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COMPUTER PROGRAM FOR THE PREDICTION OF AIRCRAFT RESPONSE TO RUNWAY ROUGHNESS. VOLUME II. USER'S MANUAL

Anthony G. Gerardi, et al

Air Force Flight Dynamics Laboratory

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April 1974

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13. ABSTRACT

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A computer program has been developed for use in determining the dynamic response of an aircraft to runway roughness during takeoff and constant speed taxi. The mathematical model has been programmed in Fortran for a CDC 6600 digital computer. A typical takeoff simulation requires less than 200 seconds of computer time and less than 77,000 octal storage locations. The output from the program is in two formats, a digital listing and a Calcomp-plotted time history. The plotted output is very useful in evaluating results.

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Aircraft dynamic response Runway roughness Pavement smoothness Aircraft/pavement interaction Aircraft vertical accelerations						

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Volume II

User's Manual

Anthony G. Gerardi
Adolph K. Lohwasser

Air Force Flight Dynamics Laboratory
Wright-Patterson Air Force Base, OH 45433

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FOREWORD

This report was prepared by the Air Force Flight Dynamics Laboratory under AFWL Project Order 72-025. The research was performed under Program Element 63723F, Project 683M, Task 04.

The inclusive dates of research were October 1971 through April 1973. The report was submitted 11 February 1974 by the Air Force Weapons Laboratory Project Engineer, Mr. L. M. Womack (DEZ).

This report is composed of two volumes. Volume I, Program Development, contains a complete description of the mathematical model used to represent any aircraft during taxi or takeoff. Volume II, User's Manual, consists of a description of the usage and form of the computer program TAXI which simulates the aircraft.

Acknowledgement is due to F. J. Milfeit who contributed significantly to the collecting and cataloging of airplane data, to J. J. Guckian for assistance in flow charting the computer program, and J. J. Olsen, B. M. Crenshaw, Major H. L. Russell and R. F. Cook for technical and administrative assistance.

This technical report has been reviewed and is approved.

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WILLIAM B. LIDDICOET
Colonel, USAF
Chief, Civil Engineering Research Division

ABSTRACT

(Distribution Limitation Statement A)

A computer program has been developed for use in determining the dynamic response of an aircraft to runway roughness during takeoff and constant speed taxi. The mathematical model has been programmed in Fortran for a CDC 6600 digital computer. A typical takeoff simulation requires less than 200 seconds of computer time and less than 77,000 octal storage locations. The output from the program is in two formats, a digital listing and a Calcomp-plotted time history. The plotted output is very useful in evaluating results.

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SECTION I

INTRODUCTION

This volume contains a detailed presentation of the form and use of the program "TAXI", which will compute the dynamic response of an aircraft to a runway profile. This program consists of one main program and four subroutines. Input to the program consists of airplane data on punched cards and a runway profile on magnetic tape. Its output includes a listing of ten aircraft parameters at given time intervals and a time history Calcomp plot of center of gravity and pilot station vertical accelerations and the runway profile traversed by the nose gear of the aircraft.

This program will enable the user to simulate any aircraft traversing a runway profile with a minimum of modification to the computer code. The phrase "conventional landing gear aircraft" refers to aircraft with one set of main landing gear which are nonarticulated and of the single-acting type such as the C-141, KC-135 and B-52. Several nonconventional landing gear aircraft include the F-4, F-111 and C-5A. All conventional landing gear aircraft can be simulated with only a change in the aircraft input data. In contrast, the F-4, which is not a conventional landing gear aircraft, requires a change in aircraft data and the substitution of two subroutines in the basic computer program with those designated for use for the F-4. Simulation of the F-111 also requires a change in aircraft data and substitution of two subroutines in the basic computer program with those designated for the F-111. Due to the complexities of modifying the basic program by substitution of subroutines for the C-5A aircraft, which has two

sets of main gear that are double-acting, a completely separate deck is used.

In order to facilitate the use of the program TAXI, this volume also contains a detailed description of the program in its basic form and the modifications of the basic source deck required for the F-4, F-111 and C-5A simulations. First, the form of the aircraft input data cards and runway profile tape are described along with the general setup of the program source deck. Next, program flow charts are shown. Finally, the output listing and plot are discussed. A complete listing of the program and Fortran symbols are contained in appendices 1 and 2.

SECTION II

PROGRAM OPERATION PROCEDURES

General Procedures

Before the program TAXI can be used for a runway roughness analysis, the following procedures must be followed.

First, adequate computer core memory space must be specified. For all simulations a core memory of 77000 octal words is required.

Second, sufficient computer time must also be specified. Central processor (CP) time is a function of the integration step size, number of flexible modes included in the analysis, and the type of simulation, either a taxi or takeoff. In order to estimate this CP time, the following examples can be used. Using the recommended integration step size of 0.001 sec., a takeoff with 10 modes of vibration included requires CP time of 2.5 sec. for every second of actual simulation time. For a taxi with 10 modes included, CP time is 2.0 sec. for every second of actual simulation time. Including fewer vibration modes and a larger step size, the result will be less CP time required while more modes and a smaller integration step size will require more time. These estimates are for a CDC 6600 computer. Other machines may require more or less time.

Third, a set of data cards for the aircraft being simulated must be punched and a magnetic tape on which the runway profile is stored must be obtained. The formats for the aircraft data cards and magnetic tape are contained in Section II of this Volume.

Fourth, the modifications of the basic source deck must be made if an F-4, or F-111 simulation is to be run. If a C-5A aircraft is to be simulated, the source deck designated for this particular aircraft must be used. Instructions for the modification of the basic source deck for an F-4 or F-111 simulation are contained in Section II of this volume.

Finally, the entire deck including control cards, source deck and aircraft data cards must be assembled as shown in this section.

Aircraft Input Data

The following tables contain the form of the aircraft input data required for an aircraft/airfield simulation. The data cards are sequenced as they must appear in the aircraft data deck. For each data card variable names, definitions, units, card columns and format field specifications are given.

Table I contains the form of the aircraft data deck for all conventional landing gear aircraft such as the C-141, KC-135 and B-52. These aircraft all have a single set of main landing gear which are single-acting and are nonarticulated.

Table II shows the modifications of certain cards in Table I which are necessary for an F-4 simulation. All other cards remain the same.

Table III contains the changes to various cards in Table I for an F-111 simulation. All other data cards remain the same.

Similarly, Table IV contains the changes to certain data cards in Table I required for a C-5A simulation. Again, all other data cards remain unchanged.

The aircraft input data for the C-141, KC-135, B-52, F-111, F-4 and C-5A aircraft are contained in Volume I of this report. A sample aircraft input data deck for the KC-135 aircraft is shown in Table VI.

TABLE I

AIRCRAFT DATA FOR CONVENTIONAL AIRCRAFT

Section 1 (cards 1-5) - General Airplane Data

Card Column	Format	Variable Name	Definition
Card 1			
1-80	8A10	PLANE	Airplane Being Simulated and Gross Weight
Card 2			
1-10	F10.1	W	Vehicle Weight (lbs)
11-20	F10.1	A	Distance Main Gear to CG (in)
21-30	F10.1	B	Distance Nose Gear to CG (in)
31-42	F12.0	MMI	Mass Moment of Inertia (lb in sec^2)
Card 3			
1-10	F10.2	PSARM	Distance of Pilot Station to CG (in)
11-20	F10.2	TAILRM	Distance of Tail Station to CG (in)
Card 4			
1-10	F10.2	SPEED	Initial Velocity of Airplane (ft/sec)
11-20	F10.2	THRUST	Total Airplane Thrust (lbs)
21-30	F10.2	TAKOFF	Airplane Rotation Speed (ft/sec)
Card 5			
1-10	F10.4	CL	Lift Coefficient
11-20	F10.4	AREA	Wing Area (ft^2)
21-30	F10.4	CD	Drag Coefficient

Section 2 (cards 6-11) - Main and Nose Gear

Card Column	Format	Variable Name	Definition
Card 6			
1-10	F10.2	WM	Unsprung Weight of Each Main Gear (lbs)
11-20	F10.2	WN	Unsprung Weight of Nose Gear (lbs)
21-30	F10.2	SXM	Number of Main Gear Struts
31-40	F10.2	SXN	Number of Nose Gear Struts

TABLE I (Con't)

Card Column	Format	Variable Name	Definition
Card 7			
1-10	F10.5	AHN	Hydraulic Piston Area Nose (in^2)
11-20	F10.5	AAN	Pneumatic Piston Area Nose (in^2)
21-30	F10.5	AHM	Hydraulic Piston Area Main (in^2)
31-40	F10.5	AAM	Pneumatic Piston Area Main (in^2)
Card 8			
1-10	F10.5	PAON	Nose Strut Preload Pressure (lbs/in^2)
11-20	F10.5	PAOM	Main Strut Preload Pressure (lbs/in^2)
21-30	F10.5	VON	Fully Extended Nose Strut Air Volume (in^3)
31-40	F10.5	VOM	Fully Extended Main Strut Air Volume (in^3)
41-50	F10.5	OAM	Orifice Area Main (in^2)
51-60	F10.5	OAN	Orifice Area Nose (in^2)
Card 9			
1-10	F10.3	SLM	Distance from Axle to CG Waterline Main Gear Strut Unloaded (in)
11-20	F10.3	SLN	Distance from Axle to CG Waterline Nose Gear Strut Unloaded (in)
Card 10			
1-10	F10.1	TSMI	Main Tire Spring Constant Per Strut (lbs/in)
11-20	F10.1	TSNI	Nose Tire Spring Constant Per Strut (lbs/in)
Card 11			
1-10	F10.5	DX	Integration Step Size
Card 12			
1-5	I5	IFPLOT	0 Plot 1 No Plot

Section 3 (cards 13-16)-Metering Pin Description

Card Column	Format	Variable Name	Definition
Card 13			
1-5	I5	NSCN	Number of Slope Changes Nose Gear

TABLE I (Con't)

Card Column	Format	Variable Name	Definition
*Card 14A, 14B,....			
1-10	F10.3	STROKN	Stroke Corresponding to Metering Pin Diameter, Nose Gear
11-20	F10.3	PINDN	Metering Pin Diameter, Nose Gear (in)
Card 15			
1-5	I5	NSCM	Number of Slope Changes Main Gear
*Card 16A, 16B,....			
1-10	F10.3	STROKM	Stroke Corresponding to Metering Pin Diameter, Nose Gear
11-20	F10.3	PINDM	Metering Pin Diameter, Main Gear (in)
			Section 4 (cards 17-19)-Flexibility Data
Card 17			
1-5	I5	NFM	Number of Flexible Modes
**Card 18A, 18B,.....			
1-10	F10.3	SIMAIN	Mode Shape Deflection Main Gear
11-20	F10.3	SINOSE	Mode Shape Deflection Nose Gear
21-30	F10.3	SICG	Mode Shape Deflection CG
31-40	F10.3	SITAIL	Mode Shape Deflection Tail Station
41-50	F10.3	SIPS	Mode Shape Deflection Pilot Station
**Card 19A, 19B,....			
1-15	F15.2	GM	Generalized Mass (lbs sec^2/in)
16-25	F10.3	OMEGA	Modal Frequency (rad/sec)

*One card is required for each stroke-metering pin combination read into the program.
**One card is required for each flexible mode.

TABLE II

INPUT DATA CHANGES FOR THE F-4

Card Column	Format	Variable Name	Definition
Card 13			
1-5	I5	NSCN	Number of area changes in nose gear metering tube
*Card 14A, 14B,....			
1-10	F10.3	STROKN	Stroke corresponding to orifice area, nose gear
11-20	F10.3	PINDN	Net orifice area at STROKN, nose gear (in^2)
*Card 15			
1-5	I5	NSCM	Number of area changes in main gear metering tube
*Card 16A, 16B,....			
1-10	F10.3	STROKM	Stroke corresponding to orifice area, main gear
11-20	F10.3	PINDM	Net orifice area at STROKM, main gear (in^2)

*One card is required for each stroke-metering pin combination read into the program

TABLE III

INPUT DATA CHANGES FOR THE F-111

Card Column	Format	Variable Name	Definition
Card 13			
1-5	I5	NSCN	Number of area changes in nose gear fluted metering pin
*Card 14A, 14B,....			
1-10	F10.3	STROKN	Stroke corresponding to orifice area, nose gear
11-20	F10.3	PINDN	Net orifice area at STROKN, Nose Gear (in^2)
Card 15			
1-5	I5	NSCM	Number of area changes in main gear fluted metering pin
*Card 16A, 16B,....			
1-10	F10.3	STROKM	Stroke corresponsing to orifice area, main gear
11-20	F10.3	PINDM	Net orifice area at STROKM, main gear (in^2)

* One card is required for each stroke - metering pin combination read into the program.

TABLE IV

INPUT DATA CHANGES FOR THE C-5

Card Column	Format	Variable Name	Definition
Card 2			
1-10	F10.1	W	Vehicle Weight (lbs)
11-20	F10.1	A	Distance from Rear Main to CG (in)
21-30	F10.1	B	Distance from Nose Gear to CG (in)
31-40	F10.1	C	Distance from Front Main to CG (in)
41-52	F12.0	MMI	Mass Moment of Inertia (lb-in-sec^2)
Card 13			
1-5	I5	NSCN	Number of Area Changes in Nose Gear Metering Tube
*Card 14A, 14B,....			
1-10	F10.3	STROKN	Stroke Corresponding to Orifice Area, Nose Gear
11-20	F10.3	PINDN	Net Orifice Area at STROKN, Nose Gear (in^2)
Card 15			
1-5	I5	NSCM	Number of Area Changes in Main Gear Metering Tube
*Card 16A, 16B,....			
1-10	F10.3	STROKM	Stroke Corresponding to Orifice Area, Main Gear
11-20	F10.3	PINDM	Net Orifice Area at STROKM, Main Gear (in^2)
**Card 18A, 18B,....			
1-10	F10.3	SIMAIN1	Mode Shape Deflection Rear Main Gear
11-20	F10.3	SIMAIN2	Mode Shape Deflection Front Main Gear
21-30	F10.3	SINOSE	Mode Shape Deflection Nose
31-40	F10.3	SICG	Mode Shape Deflection CG
41-50	F10.3	SITAIL	Mode Shape Deflection Tail Station
51-60	F10.3	SIPS	Mode Shape Deflection Pilot Station

* One card is required for each stroke-metering pin combination read into the program

** One card is required for each flexible mode.

Runway Profile Magnetic Tape

The runway profile is read into the program from a magnetic tape. The format for this tape is shown in Table V.

TABLE V

RUNWAY PROFILE MAGNETIC TAPE

Card Column	Format	Variable Name	Definition
Card 1			
1-80	8A10	SITE	Runway Profile and Direction
Card 2			
1-6	I6	NPTSS	Number of Runway Elevation Points
*Card 3, 4, ...N+2			
1-70	10F7.3	ELEV	Runway Profile Data

* One card required for every ten runway profile elevation points.

TABLE VI

Sample Aircraft Data Deck, KC-135

KC-135 273000 POUNDS					
273000.	46.0	502.0	57772000.		
581.0	500.0				
1.00	55000.	278.88			
0.603	2433.0	0.06			
2634.0	343.0	2.0	1.0		
1317.0	24.51	64.77	82.3		
150.0	222.0	392.2	1810.0	3.149	1.227
92.0	92.0				
42352.0	11957.0				
0.01					
0					
5					
0.001	1.064				
6.41	1.129				
9.86	1.129				
13.88	1.160				
16.58	1.240				
3 3					
0.10	1.483				
12.13	1.483				
22.00	1.980				
8					
4.5	7.0	4.5	10.0	8.0	
0.0	1.5	0.0	1.0	1.0	
0.0	4.0	0.0	2.5	4.0	
-3.0	-3.0	-3.0	2.5	-3.0	
24.2	-68.0	23.0	-.410	-88.0	
7.0	-5.5	7.0	0.0	-10.0	
-1.0	-16.0	-1.0	-21.8	-24.0	
-5.0	15.0	-6.0	3.5	30.0	
81903.4	10.62				
946.62	14.51				
7128.17	15.58				
34028.44	18.47				
724890.1	20.80				
48741.8	23.69				
121052.2	29.47				
63481.19	36.88				

Deck Setup

Figures 1, 2, 3, and 4 contain schematic diagrams of the source deck setup for conventional, F-4, F-111, and C-5A aircraft simulations.

For conventional aircraft, no modifications of the basic deck are required. Only the correct aircraft input data must be used. This basic source deck setup is shown in Figure 1.

In order to simulate the F-4, however, changes must be made to the basic program. This change is a result of the main landing gear having a double-acting strut, which is described in Volume I of this report. The F-4 source deck is formed by removing the subroutines Taylor and IC from the basic source deck and replacing them with the Taylor and IC subroutines designated for use with the F-4. This is shown in Figure 2. The modifications of the aircraft data cards described in this volume must also be made.

Changes to the basic source deck for an F-111 simulation are shown in Figure 3. The use of an articulated main landing gear and a fluted metering pin on this aircraft necessitates this change. The F-111 source deck is formed by removing the Taylor and IC subroutines from the basic source deck and replacing them with the Taylor and IC subroutines designated for the F-111 aircraft. The aircraft input data changes shown in this volume must also be made.

Due to the complexities of adding an extra set of main landing gear to the basic computer code by substitution of subroutines, a completly new deck is provided for the C-5A and other muitiple strut aircraft. The source deck setup for the C-5A aircraft is shown in Figure 4. The modification of the aircraft data input for the C-5A is shown in this volume.

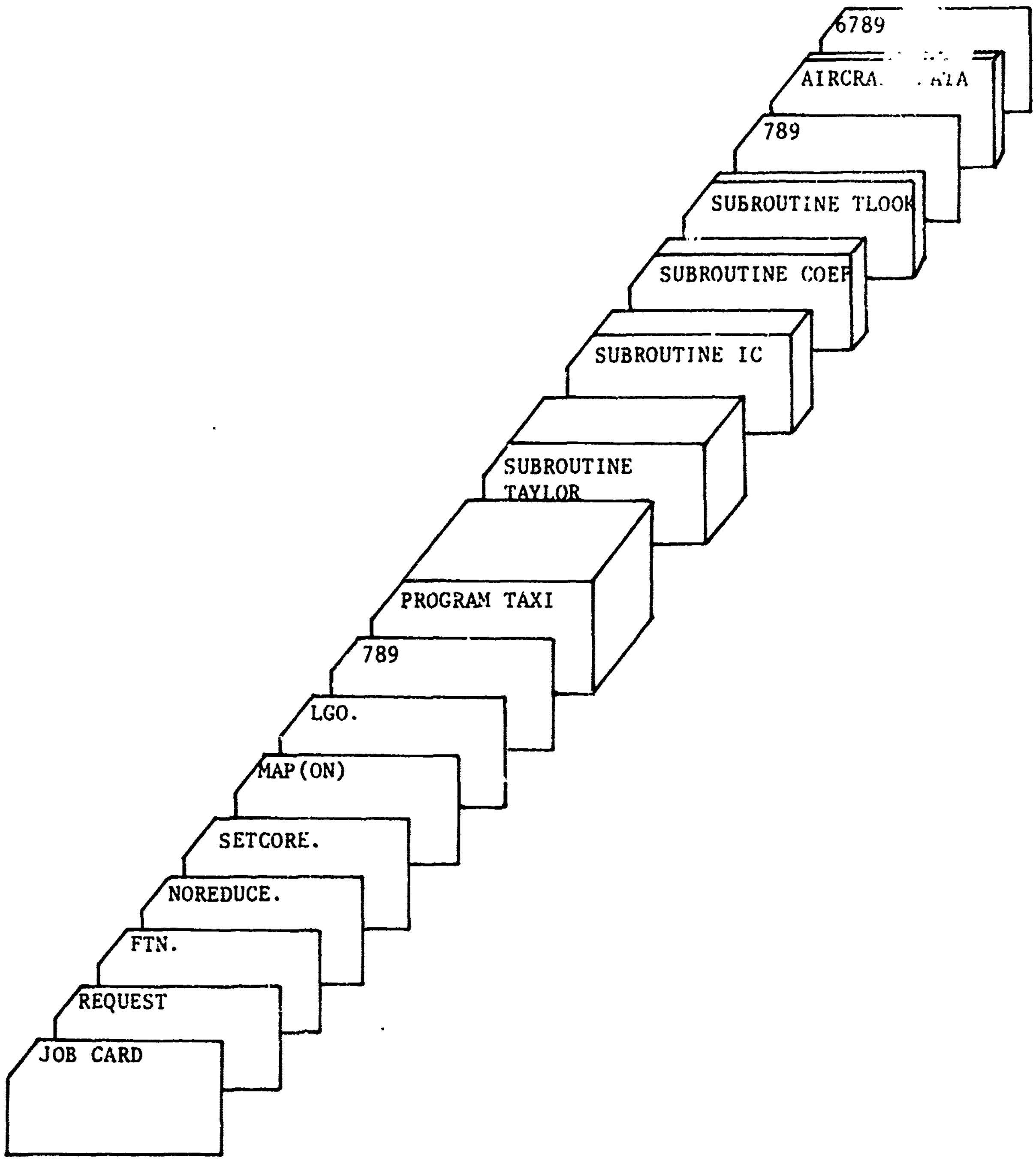


FIGURE 1. Source Deck Setup For Conventional Aircraft

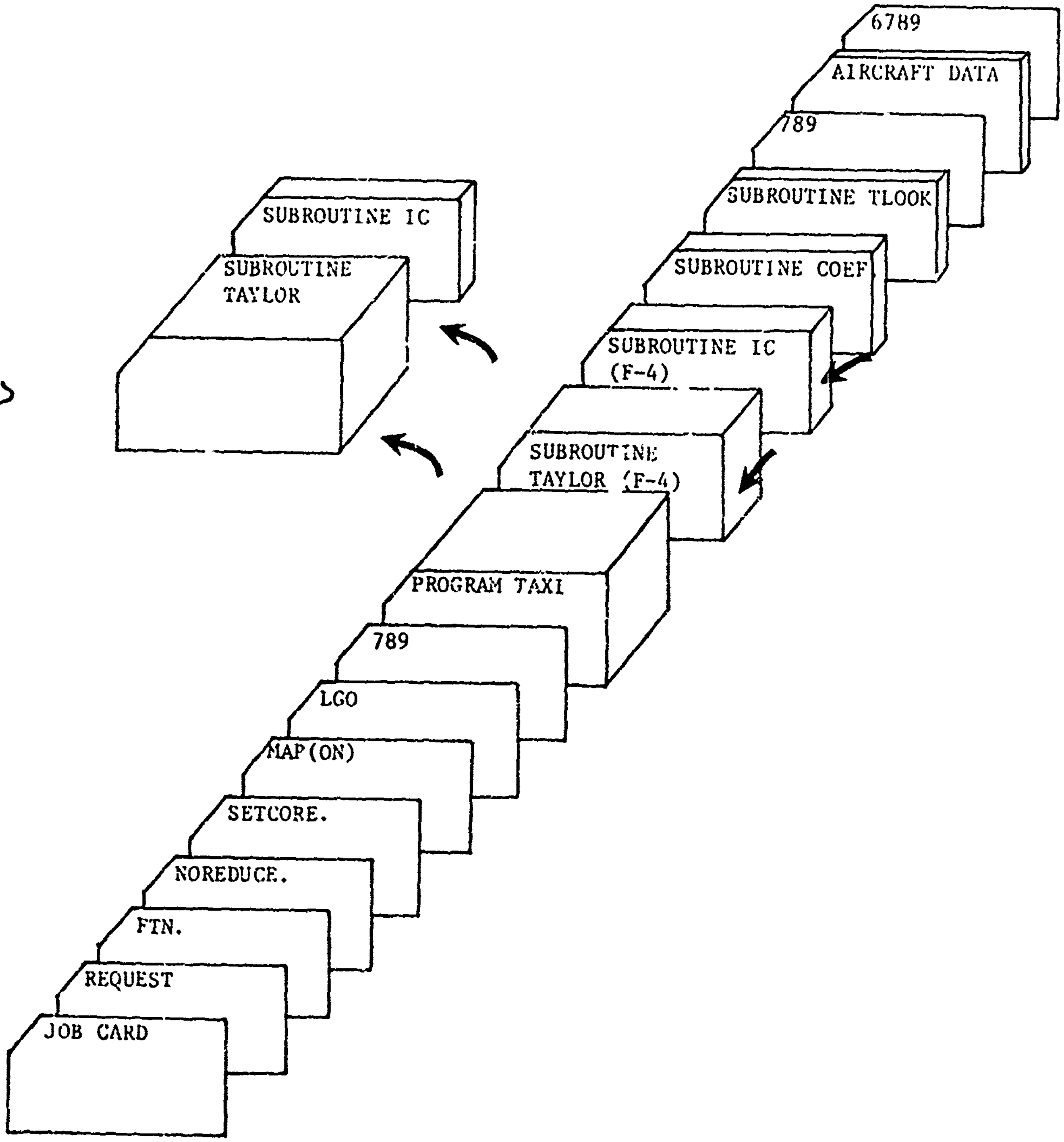


FIGURE 2. Source Deck Setup For F-4 Aircraft

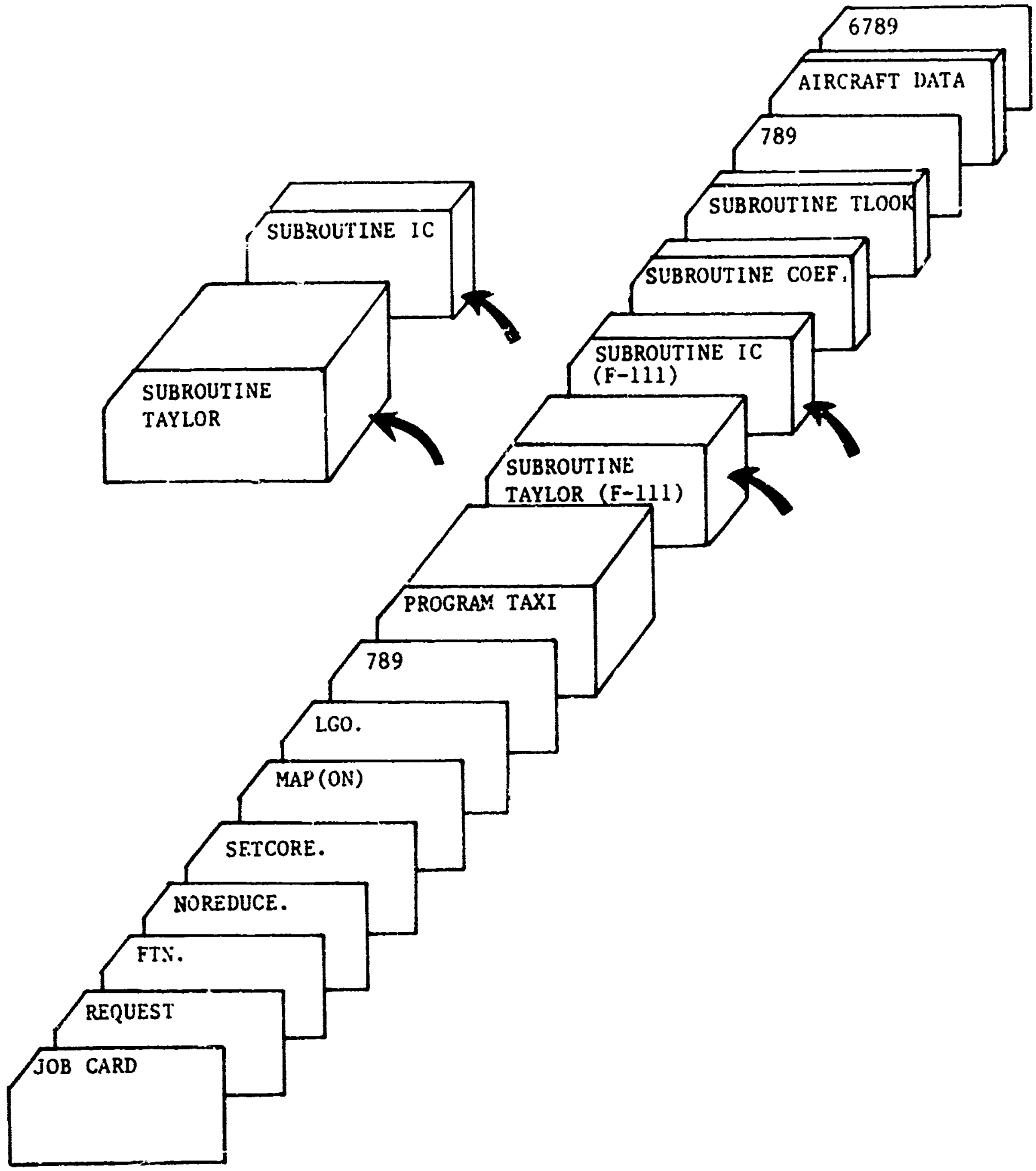


FIGURE 3 Source Deck Setup For F-111 Aircraft

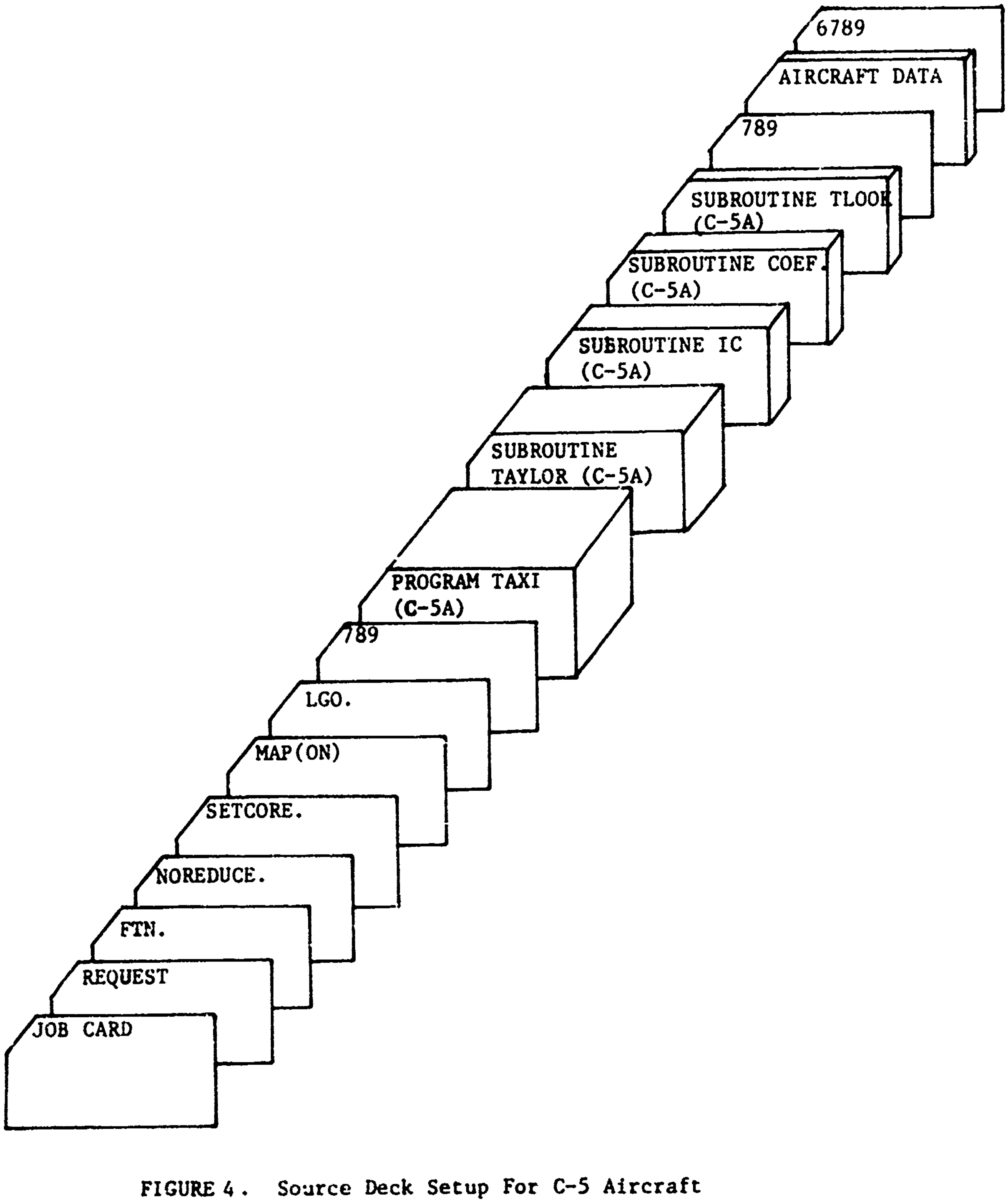


FIGURE 4. Source Deck Setup For C-5 Aircraft

SECTION III

PROGRAM DESCRIPTION

<u>Program Flow Charts</u>

The following pages contain flow charts of the program TAXI. The basic computer program is flow charted entirely. The program is broken down into its individual routines and each routine is flow charted separately. The flow charting symbols and their definitions are shown in Figure 5. The conventional direction of flow, from top to bottom of the page is used.

PROGRAM FLOW CHART SYMBOLS

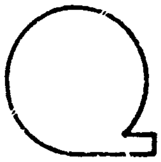
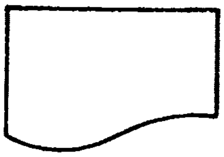
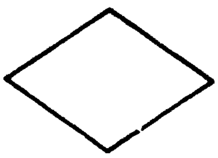
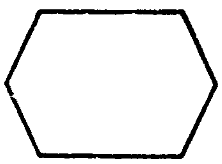
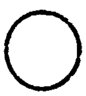
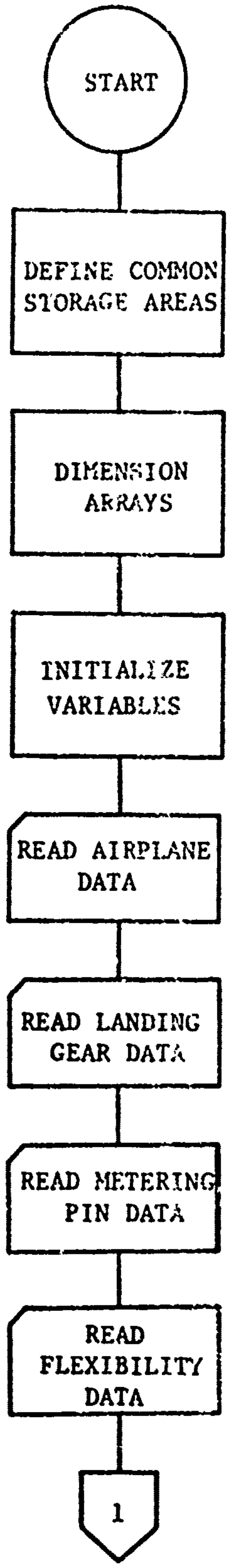
SYMBOL	DEFINITION
	Operation Box
	Card Input
	Tape Input
	Printed Output
	Decision
	Subprogram Execution
	Program Statement Number
	Page Connector
	Termination

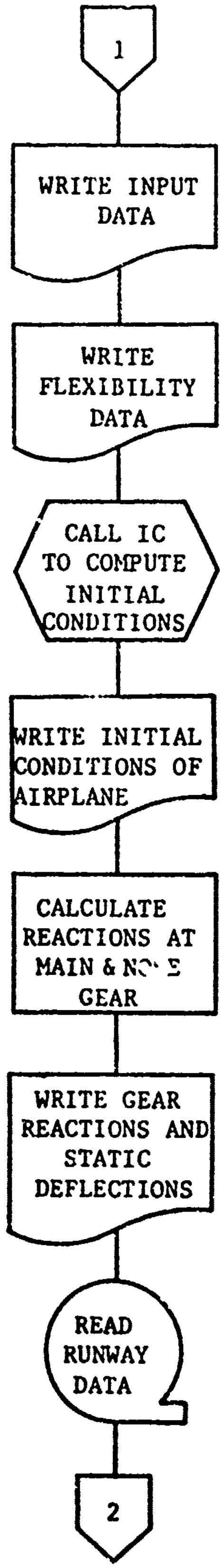
FIGURE 5. Flow Chart Symbols

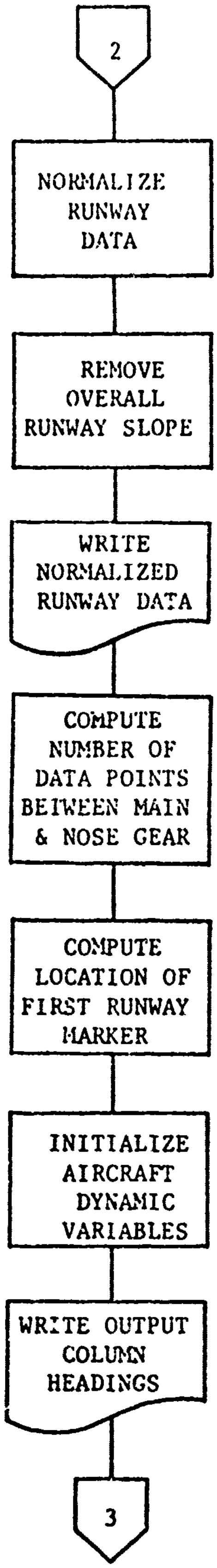
TAXI

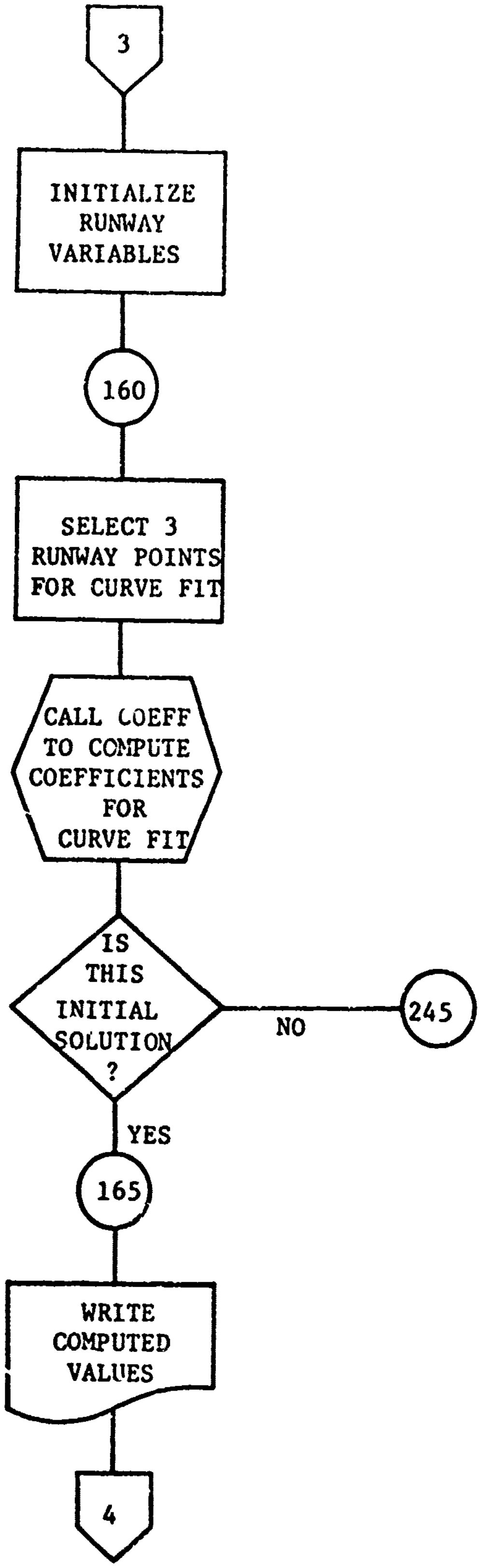
TAXI is the main routine which directs the entire program in the sequence of operations and the calculations to be made. It reads aircraft data from cards and the runway profile from a magnetic tape and outputs this data. The runway profile is both normalized to the first elevation point and detrended in TAXI. TAXI calls the subroutines IC, COEFF, and TAYLOR. IC returns aircraft initial conditions which are used to initialize aircraft dynamic variables. COEFF returns the coefficients of the polynomial fits to the runway profile segments. Taylor returns the solution to the differential equations of motion. TAXI then determines if this data is to be printed and/or stored for use in the Calcomp plot. TAXI also directs the Calcomp plotting.

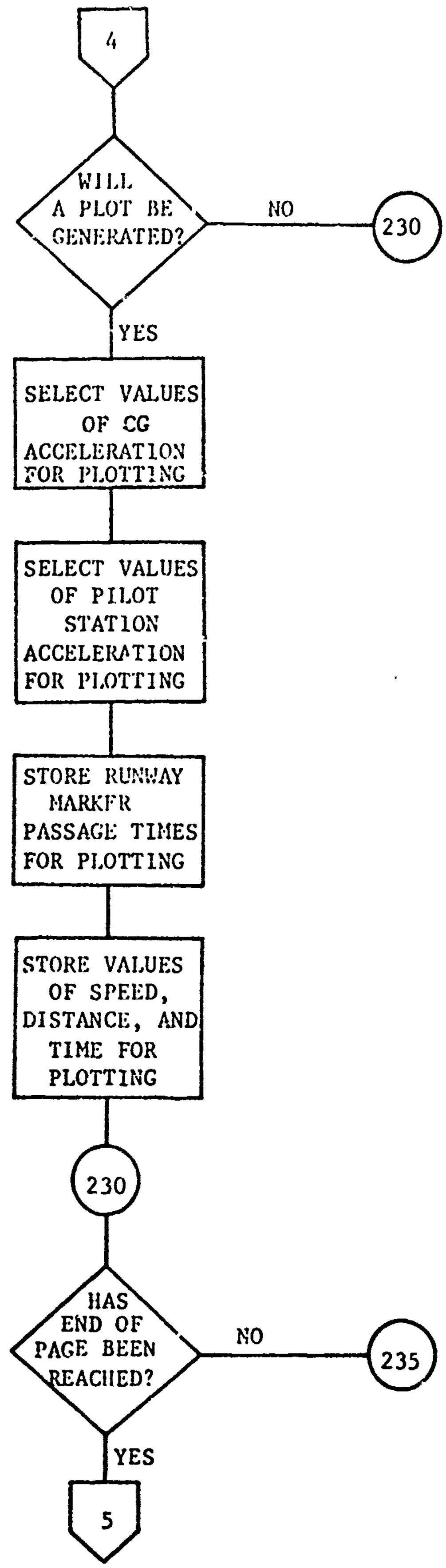
PROGRAM TAXI

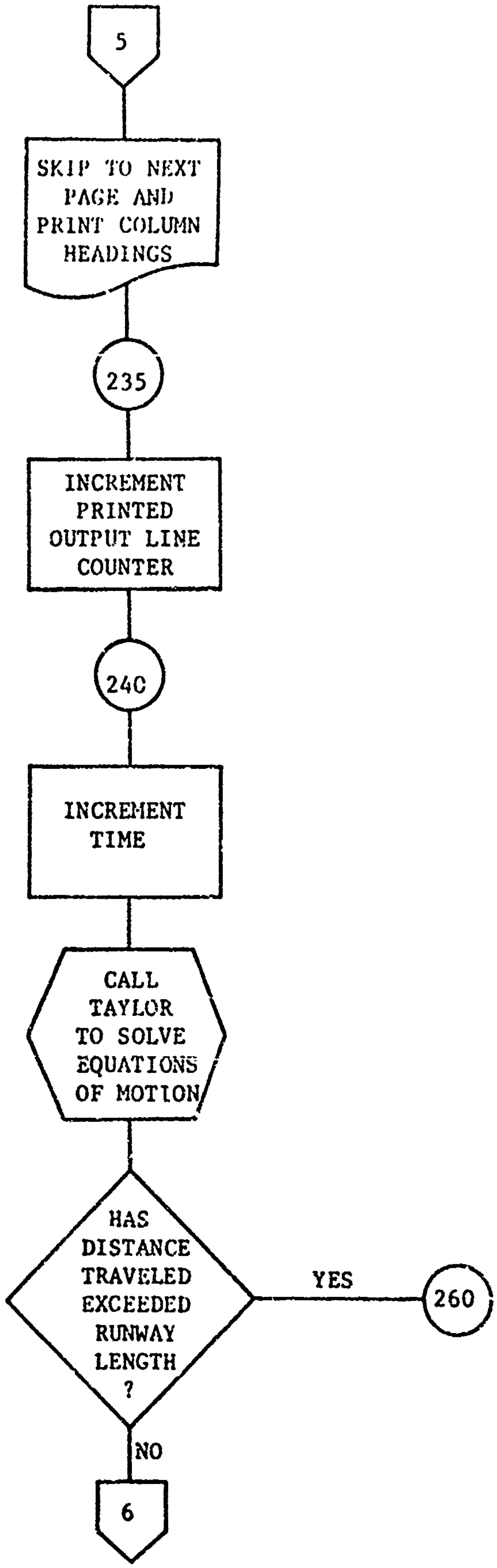


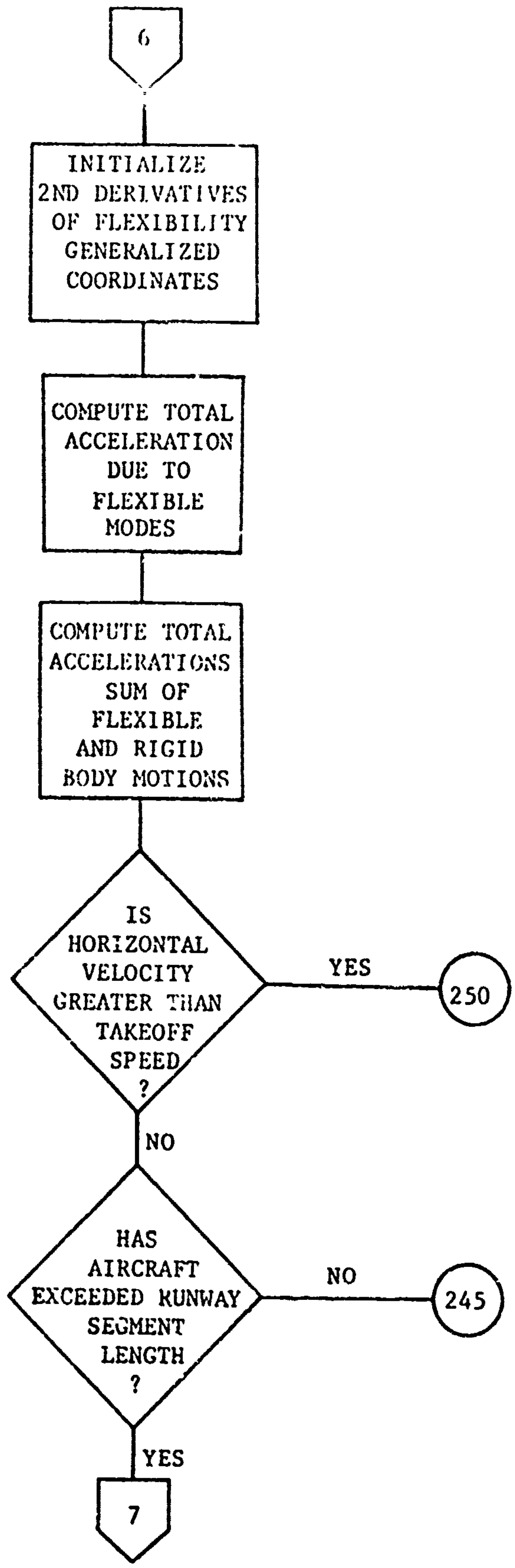

1
WRITE INPUT DATA
WRITE FLEXIBILITY DATA
CALL IC TO COMPUTE INITIAL CONDITIONS
WRITE INITIAL CONDITIONS OF AIRPLANE
CALCULATE REACTIONS AT MAIN & NOSE GEAR
WRITE GEAR REACTIONS AND STATIC DEFLECTIONS
READ RUNWAY DATA
2

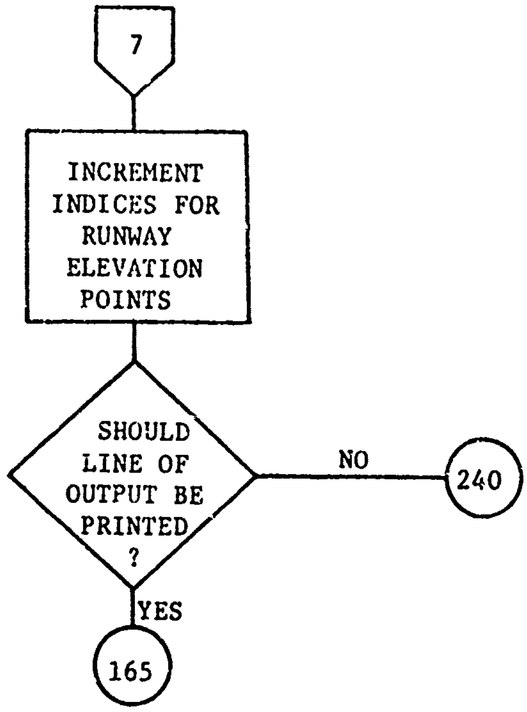

2
NORMALIZE RUNWAY DATA
REMOVE OVERALL RUNWAY SLOPE
WRITE NORMALIZED RUNWAY DATA
COMPUTE NUMBER OF DATA POINTS BETWEEN MAIN & NOSE GEAR
COMPUTE LOCATION OF FIRST RUNWAY MARKER
INITIALIZE AIRCRAFT DYNAMIC VARIABLES
WRITE OUTPUT COLUMN HEADINGS
3

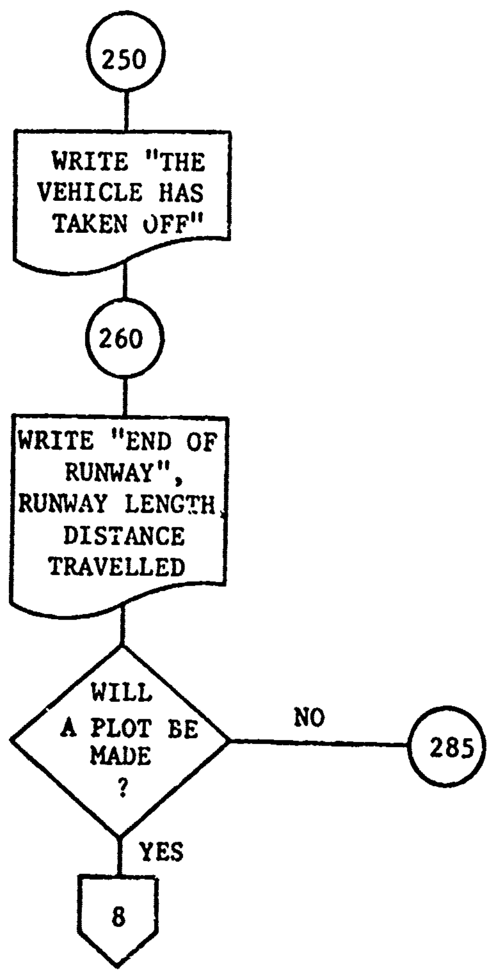

3
INITIALIZE RUNWAY VARIABLES
160
SELECT 3 RUNWAY POINTS FOR CURVE FIT
CALL COEFF TO COMPUTE COEFFICIENTS FOR CURVE FIT
IS THIS INITIAL SOLUTION ?
NO
245
YES
165
WRITE COMPUTED VALUES
4

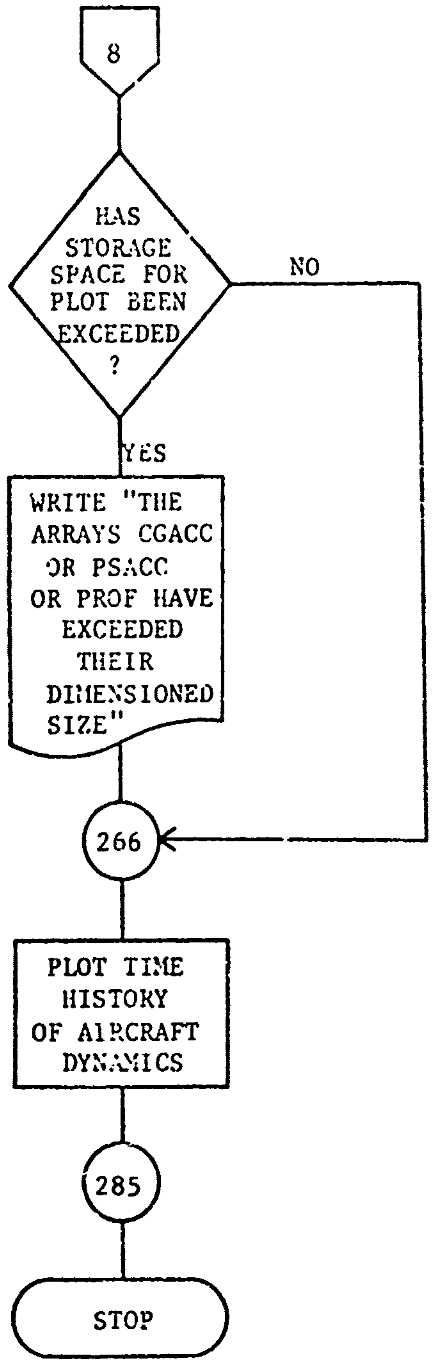

4
WILL A PLOT BE GENERATED?
NO
230
YES
SELECT VALUES OF CG ACCELERATION FOR PLOTTING
SELECT VALUES OF PILOT STATION ACCELERATION FOR PLOTTING
STORE RUNWAY MARKER PASSAGE TIMES FOR PLOTTING
STORE VALUES OF SPEED, DISTANCE, AND TIME FOR PLOTTING
230
HAS END OF PAGE BEEN REACHED?
NO
235
YES
5


5
SKIP TO NEXT PAGE AND PRINT COLUMN HEADINGS
235
INCREMENT PRINTED OUTPUT LINE COUNTER
240
INCREMENT TIME
CALL TAYLOR TO SOLVE EQUATIONS OF MOTION
HAS DISTANCE TRAVELED EXCEEDED RUNWAY LENGTH ?
YES
260
NO
6


6
INITIALIZE 2ND DERIVATIVES OF FLEXIBILITY GENERALIZED COORDINATES
COMPUTE TOTAL ACCELERATION DUE TO FLEXIBLE MODES
COMPUTE TOTAL ACCELERATIONS SUM OF FLEXIBLE AND RIGID BODY MOTIONS
IS HORIZONTAL VELOCITY GREATER THAN TAKEOFF SPEED ?
YES
250
NO
HAS AIRCRAFT EXCEEDED RUNWAY SEGMENT LENGTH ?
NO
245
YES
7


7
INCREMENT INDICES FOR RUNWAY ELEVATION POINTS
SHOULD LINE OF OUTPUT BE PRINTED ?
NO
240
YES
165

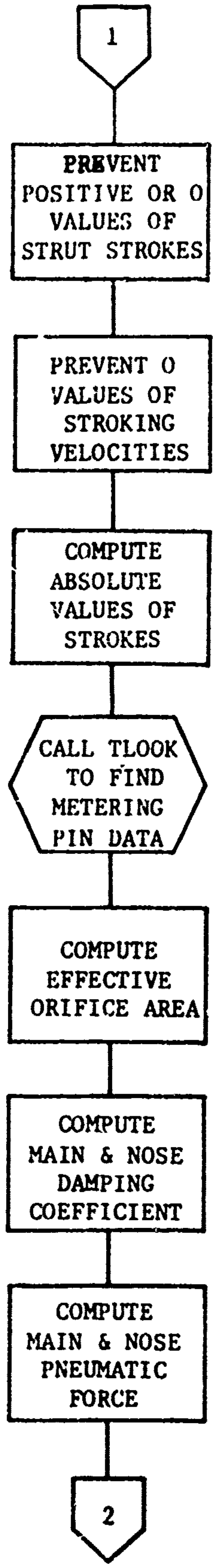

250
WRITE "THE VEHICLE HAS TAKEN OFF"
260
WRITE "END OF RUNWAY", RUNWAY LENGTH, DISTANCE TRAVELLED
WILL A PLOT BE MADE ?
NO
285
YES
8

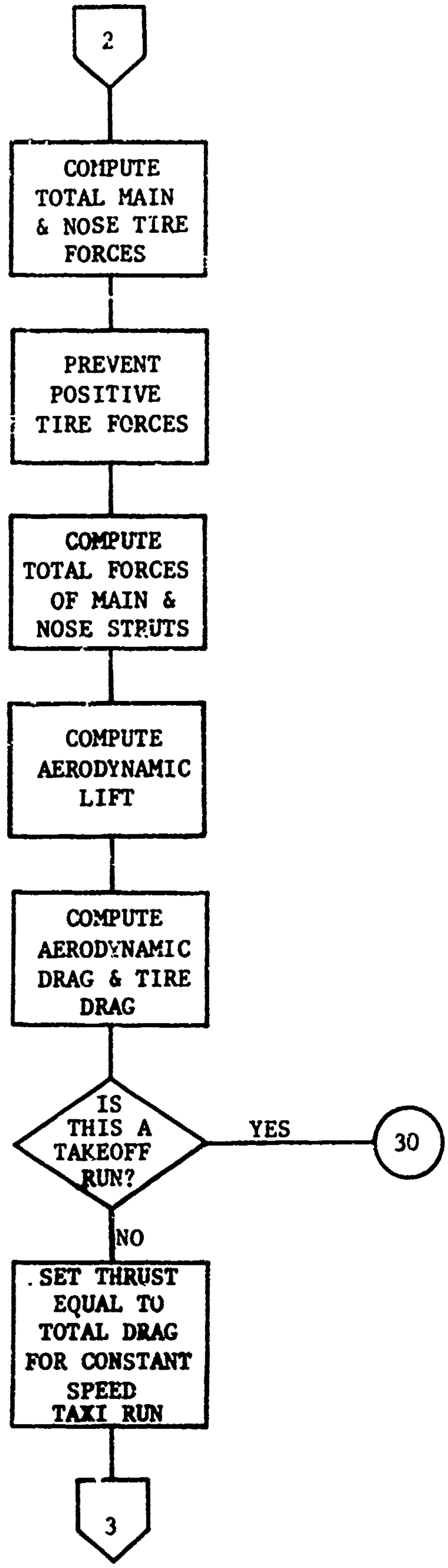

8
HAS STORAGE SPACE FOR PLOT BEEN EXCEEDED ?
NO
YES
WRITE "THE ARRAYS CGACC OR PSACC OR PROF HAVE EXCEEDED THEIR DIMENSIONED SIZE"
266
PLOT TIME HISTORY OF AIRCRAFT DYNAMICS
285
STOP

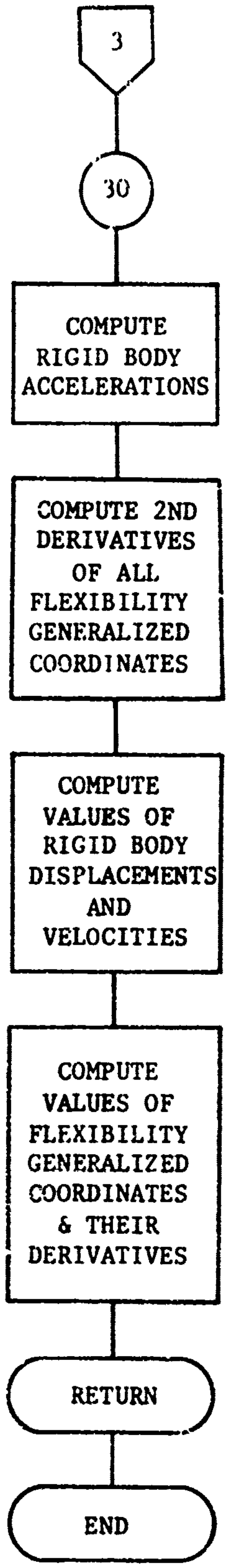
Subroutine Taylor

Taylor is the subroutine which computes the dynamic motion of the aircraft. Using runway profile information and aircraft data from TAXI and net orifice areas by calling subroutine TLOOK it calculates forces in the landing gear and tires. Subsequently, the aerodynamic and mechanical forces and moments acting on the aircraft fuselage are found. Taylor then sets up the differential equations of motion and integrates them using a three term Taylor series method. The dynamic variables are returned to TAXI for printing and storage.

SUBROUTINE TAYLOR


1
PREVENT POSITIVE OR 0 VALUES OF STRUT STROKES
PREVENT 0 VALUES OF STROKING VELOCITIES
COMPUTE ABSOLUTE VALUES OF STROKES
CALL TLOOK TO FIND METERING PIN DATA
COMPUTE EFFECTIVE ORIFICE AREA
COMPUTE MAIN & NOSE DAMPING COEFFICIENT
COMPUTE MAIN & NOSE PNEUMATIC FORCE
2

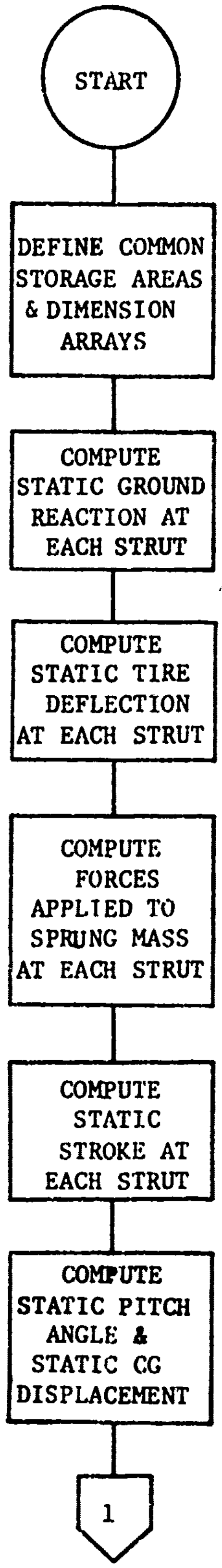

2
COMPUTE TOTAL MAIN & NOSE TIRE FORCES
PREVENT POSITIVE TIRE FORCES
COMPUTE TOTAL FORCES OF MAIN & NOSE STRUTS
COMPUTE AERODYNAMIC LIFT
COMPUTE AERODYNAMIC DRAG & TIRE DRAG
IS THIS A TAKEOFF RUN?
YES
30
NO
SET THRUST EQUAL TO TOTAL DRAG FOR CONSTANT SPEED TAXI RUN
3

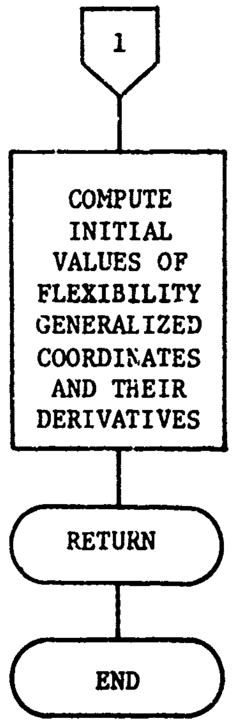

3
30
COMPUTE RIGID BODY ACCELERATIONS
COMPUTE 2ND DERIVATIVES OF ALL FLEXIBILITY GENERALIZED COORDINATES
COMPUTE VALUES OF RIGID BODY DISPLACEMENTS AND VELOCITIES
COMPUTE VALUES OF FLEXIBILITY GENERALIZED COORDINATES & THEIR DERIVATIVES
RETURN
END

Subroutine IC

This subroutine calculates the static conditions of the aircraft needed to initiate an aircraft simulation. From statics, the reaction force at the main and nose gears are calculated by summing moments and forces. Tire deflections and main and nose gear strut stroke are computed from these reactions. Using these values, the initial aircraft pitch angle and the initial vertical position of the CG are found. These values are returned to the main routine TAXI.

SUBROUTINE IC

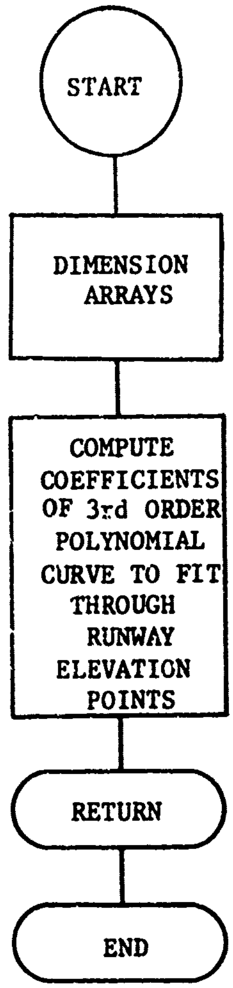



1
COMPUTE INITIAL VALUES OF FLEXIBILITY GENERALIZED COORDINATES AND THEIR DERIVATIVES
RETURN
END

Subroutine COEFF

COEFF calculates a third order polynomial fit to a four foot runway profile segment. Given three runway elevation points and the slope from the end of the previous runway segment, a set of four simultaneous equations is solved. This solution yields the four constant coefficients of the runway segment polynomial. This subroutine calculates a runway profile segment fit for each set of landing gear after each four foot traversal of the runway. The coefficients are returned to TAXI and used in Taylor for computing the runway profile elevations at each time step during a simulation.

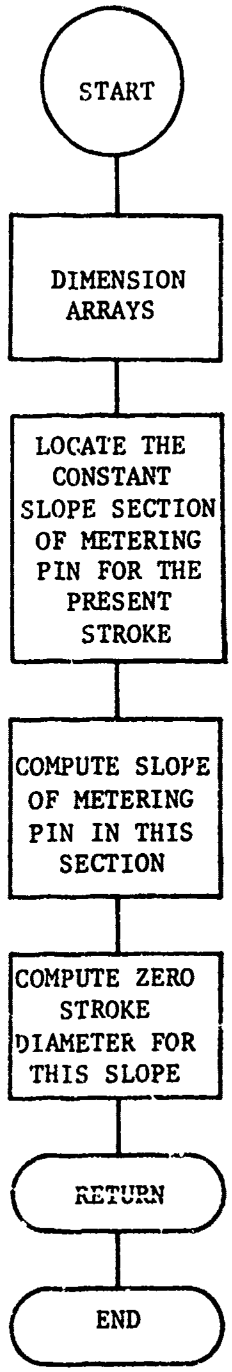
SUBROUTINE COEFF



Subroutine TLOOK

TLOOK performs a linear interpolation of the values in the table of metering pin diameter vs. stroke. For an aircraft with a metering tube or fluted metering pin, this table becomes net orifice area vs. stroke. In either case TLOOK is called by Taylor and furnished with a landing gear strut stroke. It does a table look-up and fits a straight line between the two points which straddle the given strut stroke. The slope and y-intercept of this line are returned to Taylor where a net orifice area is computed. TLOOK is called at each time step during a simulation for each set of landing gear of the aircraft.

SUBROUTINE TLOOK



SECTION IV

PROGRAM OUTPUT

The results of the program are presented in two forms. These are a listing of ten dynamic aircraft parameters and a Calcomp plot.

The listing of the dynamic aircraft parameters occurs at specified time intervals during an aircraft simulation which are larger than the integration step size. For a take-off simulation printing occurs at .01 second intervals. If a constant speed taxi simulation is made, printing occurs every .02 seconds. These intervals are model simulation times not real time. Thus, using an integration step size of .001 seconds, ten or twenty solution integrations are made between every line of printing. The ten aircraft parameters selected for printing are main gear stroke, nose gear stroke, main gear force, nose gear force, speed of the aircraft, distance down the runway, tail acceleration, CG acceleration, pilot station acceleration, and simulation time. Other variables may be printed out by modifying the WRITE statement in the main routine TAXI and putting the variable in COMMON between TAXI and the routine in which it is defined. A sample page of printed output is shown in Figure 6.

The other form of output is the Calcomp plot. On this plot, CG acceleration and pilot station acceleration time histories are displayed along with the runway profile time history as seen by the nose gear of the aircraft. Aircraft speed and distance and runway markers are also plotted at specified intervals. A more complete description of the Calcomp plot is contained in Volume I of this report. A photographic reduction of a typical Calcomp plot is shown in Figure 7.

XMAIN	XNOS	FSM	FSN	TAILAC	SPEED	DIST	CGACC	PSA	TIME
-11.733	-11.526	-264213.	-177249.	.028	134.000	5363.840	-.033	.007	43.76
-11.682	-11.454	-210955.	-175521.	.174	134.000	5366.520	.011	-.066	43.78
-11.765	-11.479	-198652.	-177022.	-.057	134.000	5369.210	-.055	.031	43.80
-11.731	-11.572	-208261.	-179275.	.004	134.000	5371.880	.015	-.020	43.82
-11.831	-11.451	-206322.	-175580.	-.014	134.000	5374.560	-.005	-.060	43.84
-11.592	-11.627	-197695.	-164465.	-.138	134.000	5377.240	-.037	.092	43.86
-11.555	-11.645	-197533.	-180179.	-.139	134.000	5379.920	-.041	.031	43.88
-11.677	-11.534	-203398.	-178449.	-.094	134.000	5382.600	-.005	-.041	43.90
-11.724	-11.711	-202869.	-185801.	-.136	134.000	5385.280	.015	-.040	43.92
-11.687	-11.623	-202570.	-176778.	-.115	134.000	5387.960	.012	-.079	43.94
-11.598	-11.591	-191169.	-185730.	-.249	134.000	5390.640	-.055	.093	43.96
-11.353	-11.922	-190635.	-195105.	-.291	134.000	5393.320	-.035	.195	43.98
-11.523	-11.974	-196785.	-192630.	-.242	134.000	5396.000	.001	.138	44.00
-11.463	-11.093	-193411.	-175642.	-.224	134.000	5398.680	-.064	-.096	44.02
-11.401	-11.540	-194830.	-179507.	-.260	134.000	5301.360	-.041	-.066	44.04
-11.594	-11.602	-199294.	-182493.	-.195	134.000	5304.040	-.003	-.060	44.06
-11.613	-11.047	-199152.	-181990.	-.164	134.000	5306.720	-.037	-.060	44.08
-11.544	-11.035	-196947.	-183545.	-.191	134.000	5309.400	-.021	-.016	44.10
-11.527	-11.017	-190139.	-179957.	-.164	134.000	5312.080	-.041	-.038	44.12
-11.572	-11.009	-199397.	-184947.	-.124	134.000	5314.760	-.009	.021	44.14
-11.715	-11.775	-203447.	-180493.	-.075	134.000	5317.440	.012	.043	44.16
-11.591	-11.333	-197814.	-188712.	-.109	134.000	5320.120	-.023	.129	44.18
-11.775	-11.332	-211809.	-189867.	.034	134.000	5322.800	.064	.071	44.20
-11.915	-11.340	[illegible]	-191755.	.032	134.000	5325.480	.057	.115	44.22
-11.777	-11.736	-203677.	-183088.	.031	134.000	5328.160	-.004	.059	44.24
-11.972	-11.730	-217594.	-188122.	.134	134.000	5330.840	.078	.038	44.26
-11.993	-11.344	-211991.	-188891.	.092	134.000	5333.520	.139	.083	44.28
-12.003	-11.743	-211528.	-184540.	.114	134.000	5336.200	.021	.027	44.30
-12.211	-11.714	-230435.	-184345.	.283	134.000	5338.880	.134	-.094	44.32
-12.327	-11.778	-228292.	-187134.	.277	134.000	5341.560	.123	-.045	44.34
-12.127	-11.749	-211145.	-184387.	.139	134.000	5344.240	-.005	.046	44.36
-11.927	-11.558	-212641.	-177207.	.193	134.000	5346.920	-.039	-.046	44.38
-11.993	-11.940	[illegible]	-179836.	.260	134.000	5349.600	.012	-.008	44.40
[illegible]	-11.601	-210647.	-183239.	.161	134.000	5352.280	-.002	.036	44.42
-11.572	-11.404	-214366.	-174606.	.201	134.000	5354.960	.016	-.044	44.44
-11.964	-11.429	-208390.	-175310.	.135	134.000	5357.640	-.010	.037	44.46
-11.843	-11.551	-209138.	-176904.	.113	134.000	5360.320	.014	.041	44.48
-11.932	-11.401	-212006.	-174281.	.140	134.000	5363.000	.028	-.050	44.50
-11.593	-11.277	-211539.	-169399.	.135	134.000	5365.680	.010	-.120	44.52
-11.635	-11.247	-203250.	-176425.	.165	134.000	5368.360	.017	-.040	44.54
-11.452	-11.379	-212037.	-170947.	.133	134.000	5371.040	.023	-.147	44.56
-11.731	-11.237	-201785.	-168939.	.053	134.000	5373.720	-.047	-.107	44.58
-11.717	-11.291	-203851.	-172213.	.061	134.000	5376.400	-.026	-.075	44.60
-11.743	-11.430	-204148.	-174183.	.055	134.000	5379.080	-.017	-.036	44.62
-11.629	-11.293	-198743.	-169112.	.122	134.000	5381.760	-.063	-.046	44.64
-11.565	-11.249	-197688.	-176775.	.162	134.000	5384.440	-.060	-.003	44.66
-11.611	-11.404	-199897.	-174151.	-.161	134.000	5387.120	-.331	.031	44.68
-11.605	-11.367	-198150.	-172953.	-.023	134.000	5389.800	-.340	.023	44.70
-11.444	-11.431	-191433.	-176570.	-.149	134.000	5392.480	-.366	.091	44.72
-11.442	-11.535	-193133.	-173140.	-.119	134.000	5395.160	-.344	.065	44.74
-11.482	-11.392	-194904.	-172960.	-.109	134.000	5397.840	-.042	-.041	44.76
-11.381	-11.453	-192250.	-177242.	-.121	134.000	6300.520	-.051	.004	44.78
-11.342	-11.543	-190492.	-178543.	-.200	134.000	6303.200	-.039	-.012	44.80
-11.482	-11.558	-195118.	-179171.	-.177	134.000	6305.880	-.003	-.054	44.82
-11.435	-11.004	-192551.	-183915.	-.212	134.000	6308.560	-.012	-.029	44.84
-11.403	-11.008	-186862.	-182738.	-.274	134.000	6311.240	-.042	.030	44.86
-11.391	-11.529	-190589.	-176458.	-.163	134.000	6313.920	.001	-.104	44.88
-11.507	-11.500	-195392.	-184837.	-.193	134.000	6316.600	.010	.016	44.90
-11.412	-11.706	-191998.	-180134.	-.213	134.000	6319.280	-.016	.063	44.92
-11.403	-11.560	-195921.	-181711.	-.144	134.000	6321.960	-.014	-.010	44.94
-11.634	-11.675	-200514.	-183763.	-.090	134.000	6324.640	.009	-.007	44.96
-11.552	-11.759	-195601.	-185984.	-.119	134.000	6327.320	-.023	.057	44.98
-11.563	-11.314	-198315.	-188351.	-.062	134.000	6330.000	-.313	.072	45.00
-11.742	-11.971	-204633.	-190070.	-.019	134.000	6332.680	.024	.059	45.02
-11.079	-11.810	-202652.	-185569.	-.008	134.000	6335.360	-.006	.024	45.04
-11.733	-11.735	-207967.	-186504.	.345	134.000	6338.040	.028	.013	45.06
-11.931	-11.888	-211965.	-191631.	.073	134.000	6340.720	.067	.057	45.08
-11.756	-11.397	-204256.	-189957.	.012	134.000	6343.400	.013	.093	45.10
-11.830	-11.799	-211151.	-187237.	.085	134.000	6346.080	.350	.019	45.12
-11.950	-11.813	-213020.	-188170.	.143	134.000	6348.760	.065	.019	45.14
-11.947	-11.806	-212849.	-189777.	.096	134.000	6351.440	.069	.038	45.16
-11.915	-11.903	-215642.	-187410.	.134	134.000	6354.120	.078	-.011	45.18
-12.014	-11.747	-215382.	-185083.	.140	134.000	6356.800	.065	-.039	45.20
-11.650	-11.332	-205111.	-194829.	.030	134.000	5359.480	.025	.146	45.22
-11.007	-11.396	-213645.	-186121.	.136	134.000	6362.160	.053	-.014	45.24
-11.141	-11.573	-216503.	-175732.	.203	134.000	6364.840	.042	-.147	45.26
-11.590	-11.078	-200457.	-192746.	.058	134.000	6367.520	.024	.139	45.28
-11.333	-11.303	-208740.	-187279.	.090	134.000	6370.200	.025	.072	45.30
-11.162	-11.605	-208709.	-178671.	.114	134.000	6372.880	.004	-.023	45.32
-11.635	-11.593	-208475.	-180635.	.096	134.000	6375.560	.012	.010	45.34
-11.500	-11.564	-210677.	-177355.	.116	134.000	6378.240	.029	-.041	45.36

FIGURE 6. Program Output Listing

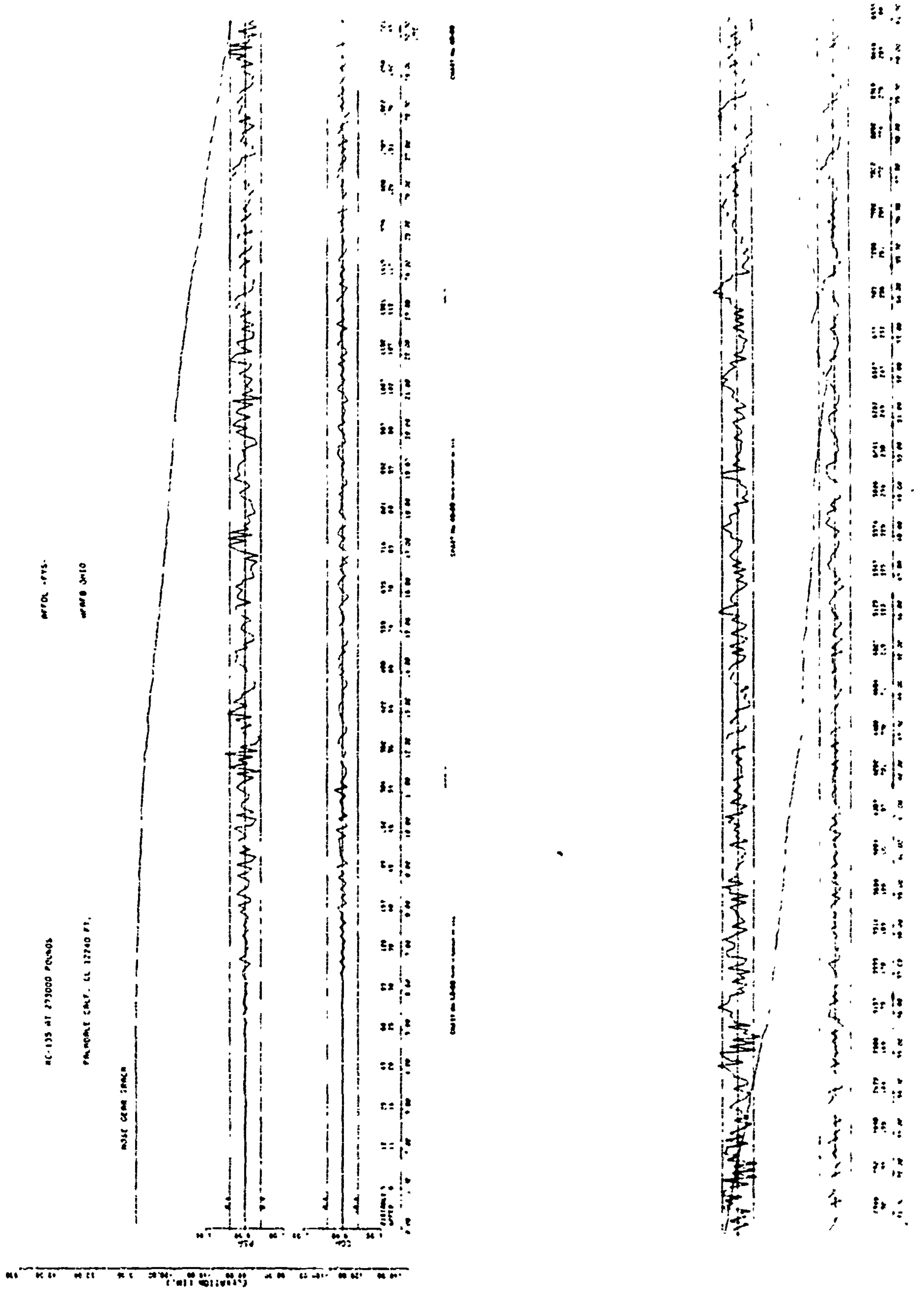


FIGURE 7. Typical Calcomp Plot

APPENDIX I

PROGRAM LISTINGS

A complete listing of the program source deck for conventional landing gear aircraft and the C-5A aircraft is given below. Listing of the TAYLOR and IC subroutines for the F-4 and F-111 simulation are also included. The programs are separated into individual routines for clarity.

```
      PROGRAM TAXI(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE3,TAPE2,
     1TAPE7)
*********************************************************************
*********************************************************************
*********************************************************************
C  THIS PROGRAM WILL PERFORM A SYMMETRIC
C  DYNAMIC TAXI ANALYSIS ON A FLEXIBLE
C  VEHICLE TRAVERSING A GIVEN RIGID RUNWAY
C  PROFILE.
*********************************************************************
*********************************************************************
*********************************************************************
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
      COMMON/FLEX2/NFM,GM(15),OMEGA(15)
      COMMON/FLEX3/Q(15),QD(15),QDD(15)
      COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,MMI
      COMMON/X2/PACM,VCM,AAM,AMM,OAM
      COMMON/X3/PACN,VON,AAN,AHN,OAN
      COMMON/X4/SXM,SXN,SLM,SLN,TSM ,TSN
      COMMON/X5/CL,CD,AREA,THRUST
      COMMON/X6/Z,REACTM,REACTN,CX,NTRUN,SPEED
      COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN
      COMMON/X8/STROKM(20),PINDM(20),STROKN(20),PINDN(20),NSCM,NSCN
      COMMON/X9/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VELM,VELN
      COMMON/X10/ZPM,ZPN
      DIMENSION PLANE(8),SITE(8)
      DIMENSION T(12), TD(12), TDD(12)
      DIMENSION ELEV(7000)
      DIMENSION YP(4),YPN(4)
      DIMENSION CGACC(1800), TIME(1800), PSACC(1800), TIME1(1600)
      DIMENSION FRCF(1800),RMARK(20)
      DIMENSION SSPLOT(300), STIME(300),DDPLOT(300)
      REAL MCG,MM,MN,MMI
      CALL PLOTS(100.,DUM,3)
      PSA=0.0
      CGOUT=0.0
      HOR=0.
      X=0.
      LLL = 1
      LL = 0
      STORE1 = 0.
      STORE2 = 0.
      STORE3 = 0.
      STORE4 = 0.
      NN = 0
      II = 0
      FP = 1.0
      M = 1
      ITT = 0
*********************************************************************
C        READ AND PRINT INPUT DATA
*********************************************************************
C   W=VEHICLE WEIGHT AT CG (POUNDS)
C   A=DISTANCE MAIN GEAR TO CG (INCHES)
C   B=DISTANCE NOSE GEAR TO CG (INCHES)
C MMI=MASS MOMENT OF INERTIA (LB IN SEC SQ)
C  PLANE= AIRPLANE BEING SIMULATED AND  GROSS WEIGHT
C  PSARM = DISTANCE OF PILOT STATION TO CG
```

```
C     TAILRM = DISTANCE OF TAIL STATION TO CG
C  TAKOFF= TAKE-OFF SPEED (FEET/SEC)
C SPEED =INITIAL  VEL  OF  AIRPLANE
C  THURST= TOTAL AIRPLANE THRUST
C  CL=LIFT COEFF.
C  AREA=WING AREA
C  CD=DRAG COEFF.
C  WM=WEIGHT OF MAIN GEAR  (EACH)
C  WN=WEIGHT OF NOSE GEAR
C  SXM= NUMBER OF MAIN GEAR STRUTS
C   SXN= NUMBER OF NOSE GEAR STRUTS
C AHN  HYDRAULIC PISTON AREA NOSE SQ INCHES
C AAN  PNEUMATIC PISTON AREA NOSE SQ INCHES
C AHM  HYDRAULIC PISTON AREA MAIN SQ INCHES
C AAM  PNEUMATIC PISTON AREA MAIN SQ INCHES
C PAON NOSE STRUT PRELOAD PRESSURE  PSI
C PAOM MAIN STRUT PRELOAD PRESSURE  PSI
C VON  NOSE STRUT INITIAL VOLUME CU. IN.
C VOM  MAIN STRUT INITIAL VOLUME CU. IN.
C OAM  ORIFACE AREA MAIN
C OAN  ORIFACE AREA NOSE
C SLM=MAIN GEAR STRUT LENGTH UNLOADED INCHES
C      DISTANCE FROM CL OF AXLE TO CG LINE
C SLN=NOSE GEAR STRUT LENGTH UNLOADED INCHES
C      DISTANCE FROM CL OF AXLE TO CG LINE
C  TSM    MAIN TIRE SPRING CONSTANT PER STRUT
C  TSN    NOSE TIRE SPRING CONSTANT PER STRUT
C  DX=TIME STEP SIZE
C  READ METERING PIN DESCRIPTION STARTING AT ZERO STROKE
C  NSCN=# OF METERING PIN CHANGES NOSE GEAR
C  NSCM=# OF METERING PIN CHANGES MAIN GEAR
C  NFM = NUMBER OF FLEXIBLE MODES
C  SIXXXX(I) = MODE SHAPE DEFLECTION (NON DIM.)
C  GM(I) = GENERALIZED MASS (POUNDS-SEC SQ/IN)
C  OMEGA (I) = MODAL FREQUENCIES (RAD/SEC)
      READ (5,1) PLANE
 1    FORMAT(8A10)
      READ(5,5) W,A,B,MMI
5     FORMAT(3F10.1,F12.0)
      READ(5,10) PSARM,TAILRM
 10   FORMAT(2F10.2)
      READ(5,15) SPEED,THRUST,TAKOFF
 15   FORMAT(3F10.3)
      READ(5,20) CL,AREA,CD
 20   FORMAT(3F10.4)
      READ(5,25) WM,WN,SXM,SXN
 25   FORMAT(4F10.2)
      READ(5,30) AHN,AAN,AHM,AAM
 30   FORMAT(4F10.5)
      READ(5,35) PAON,PAOM,VON,VOM,OAM,OAN
 35   FORMAT(6F10.5)
      READ(5,40) SLM,SLN
 40   FORMAT(2F10.3)
      READ(5,45) TSM ,TSN
 45   FORMAT(2F10.1)
      READ(5,50)DX
      READ(5,51)IFPLOT
 50   FORMAT(F10.3)
```

```
      READ(5,51) NSCN
 51   FORMAT(I5)
      READ(5,52) (STROKN(I),PINDN(I),I=1,NSCN)
 52   FORMAT(2(F10.3))
      READ(5,51)NSCM
      READ(5,52) (STROKM(I),PINDM(I),I=1,NSCM)
      READ(5,51) NFM
      READ(5,53) (SIMAIN(I),SINOSE(I),SICG(I),SITAIL(I),SIPS(I)
     1,I=1,NFM)
 53   FORMAT(5F10.3)
      READ(5,54) (GM(I),OMEGA(I),I=1,NFM)
 54   FORMAT(F15.2,F10.3)
      MM=WM/386.
      MN=WN/386.
      MCG=W/386.
      TYPRUN = .01
      NTRUN = 1
      IF(SPEED .GT. 5.) 56,57
   56 TYPRUN = .01
      NTRUN = 2
   57 WRITE(6,55)
 55   FORMAT(1H1,46X,*******************************************)
      WRITE(6,60)
 60   FORMAT(46X,46H**************** INPUT DATA *****************)
      WRITE(6,61)
 61   FORMAT(///1X,41H********* GENERAL AIRCRAFT DATA *********)
      WRITE(6,62)PLANE
 62   FORMAT(//,1X,8A10)
      WRITE(6,65) W,WM,WN,A,B,MMI
 65   FORMAT(///,5X,*W=*,F10.1,5X,*WM=*,F10.2,5X,*WN=*,F10.2,5X,
     1*A=*,F10.3,5X,*B=*,F10.3,5X,*MMI=*,F12.0)
      WRITE(6,66) SXM,SXN,SLM,SLN,PSARM,TAILRM
 66   FORMAT(//,5X,*SXM=*,F8.1,5X,*SXN=*,F9.1,5X,*SLM=*,F9.1,5X,
     1*SLN=*,F8.1,5X,*PSARM=*,F7.1,4X,*TAILRM=*,F7.1)
      WRITE(6,70) AAM,AHM,PAOM,VOM,OAM,TSM
 70   FORMAT(//,5X,*AAM=*,F8.2,5X,*AHM=*,F8.2,6X,*PAOM=*,F9.2,4X,
     1*VOM=*,F8.2,5X,*OAM=*,F8.2,5X,*TSM =*,F10.2)
      WRITE(6,74) AAN,AHN,PAON,VON,OAN,TSN
 74   FORMAT(//,5X,*AAN=*,F8.2,5X,*AHN=*,F8.2,6X,*PAON=*,F9.2,4X,
     1*VON=*,F8.2,5X,*OAN=*,F8.2,5X,*TSN =*,F10.2)
      WRITE(6,75) CL,CD,AREA,SPEED,THRUST,TAKOFF
 75   FORMAT(//,5X,*CL=*,F9.3,5X,*CD=*,F9.3,6X,*AREA=*,F8.2,5X,
     1*SPEED=*,F7.1,4X,*THRUST=*,F7.0,3X,*TAKOFF=*,F10.2)
      WRITE(6,76) (STROKN(I),PINDN(I),I=1,NSCN)
 76   FORMAT(//,3X,*STROKE NOSE   PIN DIAMETER   *//,2(3X,F10.3))
      WRITE(6,77) (STROKM(I),PINDM(I),I=1,NSCM)
 77   FORMAT(//,3X,*STROKE MAIN   PIN DIAMETER    *//,2(3X,F10.3))
      WRITE(6,80)
 80   FORMAT(1H1,1X,*MODE  SIPS   SINOSE*,4X,*  SICG   SIMAIN  SITAIL
     1OMEGA  GEN. MASS*)
      DO 85  I=1,NFM
 85   WRITE(6,90 )(I,SIPS(I),SINOSE(I),SICG(I),SIMAIN(I),SITAIL(I),
     1OMEGA(I),GM(I))
 90    FORMAT(//,    2X,I2,6(F7.2,2X),F10.1)
C ZMI =INITIAL MAIN GEAR POSITION INCHES
      WRITE(6,95)
 95   FORMAT(///,46X,40H********* INTIAL CONDITIONS ************,
C ZNI =INITIAL NOSE GEAR POSITION INCHES
```

```
C ZCGI=INITIAL C.G. POSITION INCHES
C THETAI=INITIAL PITCH ANGLE DEGREES
C   THE ABOVE PARAMETERS ARE CALCULATED IN SUBROUTINE IC
      CALL IC(  ZCGI,ZMI,ZNI,THETAI)
      WRITE(6,105) ZMI,ZNI,THETAI,ZCGI
 105  FORMAT(//,5X,4HZMI=,F10.3,5X,4HZNI=,F10.3,5X,7HTHETAI=,F10.6,
     15X,5HZCGI=,F10.3)
      REACTN=(ZNI*TSN )*SXN
      REACTM=(ZMI*TSM )*SXM
      WRITE(6,106) XMAIN,XNOSE,REACTN,REACTM
 106  FORMAT (/,3X,*XMAIN=*,F8.3,3X,*XNOSE=*,F8.3,3X,*REACTN=*,F10.0,
     13X,*REACTM=*,F10.0)
****.*** ***************************************************************
C READ RUNWAY PROFILE DATA (ELEV)
C   SITE= RUNWAY PROFILE AND DIRECTION
C  NPTSS=# OF RUNWAY ELEVATION DATA POINTS
      WRITE (6,111)
 111  FORMAT(*T*)
      DO 112 I=1,50
 112  ELEV(I)=0.0
      READ(2,1) SITE
      READ(2,116) NPTSS
      NPTSS=NPTSS+50
  116 FORMAT(I5)
      LD=51
 117  LSD = LD + 9
      READ(2,118) (ELEV(I),I=LD,LSD)
 118  FORMAT(10F7.3)
      N10=LD
      IF(LSD.GE.NPTSS) GO TO 120
      LD=LD+10
      GO TO 117
 120  ELEV1=ELEV(51)
      DO 125 I=51,N10
  125 ELEV(I) = ELEV(I) -ELEV1
      CALL RETURNS(2)
      DISTAN=0.
      LSD=LSD-90
      SLP=(LSD-50)*2
      SLP=ELEV(LSD)/SLP
      DO 126 I=51 ,N10
      ELEV(I)=ELEV(I)-SLP*DISTAN
 126  DISTAN=DISTAN+2.
      IVAL=(A+B)/24.
      WRITE(6,130)
 130  FORMAT(1H1,5X,*  RUNWAY PROFILE DATA NORMALIZED (SLOPE REMOVED)*
     150X,*FEET DOWN THE RUNWAY*)
      WRITE(6,1) SITE
      LD1=1
 135  LSD1 = LD1 + 9
      LPRIN = LSD1 * 2
      WRITE(6,140)  (ELEV(I),I=LD1,LSD1),LPRIN
 140  FORMAT(3X,10F10.5,10X,I8)
      LD1=LD1+10
      IF(LD1.GE.N10) GO TO 145
      GO TO 135
 145  WRITE(6,150) LD1
 150  FORMAT(42H********** END RUNWAY DATA ********** LD1=,I5)
```

```
      WRITE(7,1) SITE
      ENDRUN = NPTSS*2
      MRM=(ENDRUN-100.)/1000.
      RM=(((ENDRUN-100.)-FLOAT(MRM*1000))/2.)+1100.
      ENDRUN=ENDRUN-90.
      T(2) =ZCGI
      TD(2) = 0.
      T(4) = ZMI
      TD(4) = 0.
      T(6) = ZNI
      TD(6) = 0.
      T(8) = THETAI
      TD(8) = 0.
      T(10) = 0.
      TD(10) = SPEED
      WRITE(6,155)
 155   FORMAT(1H1,7X,*    XMAIN         XNOSE         FSM              FSN
     1   TAILAC          SPEED       DIST.        CGACC              PSA       TIM
     2E*)
      CZ=0.
      ZPM=0.
      ZPN=0.
      ZDOT=0.
      ZNDOT=0.
      J=1
 160  YP(1) = ZDOT
      YP(2)=ELEV(J)
      YP(3)=ELEV(J+1)
      YP(4)=ELEV(J+2)
      YPN(1)=ZNDOT
      YPN(2)=ELEV(IVAL)
      YPN(3)=ELEV(IVAL+1)
      YPN(4)=ELEV(IVAL+2)
      Z=DZ
      CALL COEFF (YPN,AN,BN,CN,DN)
      CALL COEFF (YP,AM,BM,CM,DM)
      ZDOT=BM
      ZNDOT=BN
      IF(M.GT.1) GO TO 245
      M = M + 1
 165    WRITE(6,170) XMAIN,XNOSE,FSM,FSN,TAILAC,TD(10),T(10),
     1CGOUT ,PSA,X
      WRITE(7,900) TAILAC,CGOUT,PSA
 900  FORMAT(3X,F10.3)
      TIMEX = 0.
 170   FORMAT(3X,2(3X,F10.3),2(3X,F10.0),5(3X,F10.3),2X,F6.2)
*******************************************************************************
      IF(IFPLOT.EQ.1) GO TO 230
      IF(ABS(CGOUT ).LE.ABS(STORE2).AND.ABS(STORE2).GE.ABS(STORE1))
     1GO TO 180
 175  STORE1 = STORE2
      STORE2 = CGOUT
      GO TO 190
 180  IF(X-TIME(NN).GT..08) GO TO 185
      IF(ABS(STORE2).GT..30000) GO TO 185
      GO TO 175
 185  NN = NN + 1
      CGACC(NN) = STORE2
```

```
      PROF(NN) = ZPN
      TIME(NN) = X - 10. * DX
      IF(TIME(NN).LT.0.) TIME(NN) = .01
      STORE1 = STORE2
      STORE2 = CGOUT
190   IF(ABS(PSA).LE.ABS(STORE4).AND.ABS(STORE4).GE.ABS(STORE3))
     1GO TO 205
200   STORE3 = STORE4
      STORE4 = PSA
      GO TO 215
205   IF(X-TIME1(LL).GT..08) GO TO 210
      IF(ABS(STORE4).GT..32) GO TO 210
      GO TO 200
210   LL = LL + 1
      PSACC(LL) = STORE4
      TIME1(LL)=X - 10*DX
      IF(TIME1(LL).LE.0.) TIME1(LL) = .001
      STORE3 = STORE4
      STORE4 = PSA
215   IF(ABS(T(10)-RM).LT.5.0) GO TO 220
      GO TO 225
220   II = II + 1
      RMARK(II) = X
      RM = RM + 1000.
      ITT = II
 225  IF(ABS(X-PP) .GT. .005) GO TO 230
      SSPLOT(LLL) = TD(10)
      STIME(LLL) = X
      CDPLOT(LLL) = T(10)
      LLL = LLL + 1
      PP = PP + 1.0
*********************************************************************
230   IF(HDR.LE.80.) GO TO 235
      HDR=0.
      WRITE(6,155)
235   HDR = HDR + 1.
240   X = X + DX
      CALL TAYLOR(T,TD,TDD)
      IF(T(10).GE.ENDRUN) GO TO 260
      IF(X.GE.300.) GO TO 263
      TIMEX=TIMEX+DX
       QDDCG=0.
      QDDPS=0.
      QDDTAL=0.
      DO 241 I=1,NFM
       QDDTAL=QDDTAL+QDD(I)*SITAIL(I)
      QDDCG=QDDCG+QDD(I)*SICG(I)
241    QDDPS=QDDPS+QDD(I)*SIPS(I)
      TAILAC=(TDD(2)+TAILRM*TDD(8))/386. +QDDTAL/386.
      PSA=(TDD(2)-PSARM*TDD(8))/386.      +QDDPS/386.
      CGOUT=TDD(2)/386.   +QDDCG/386.
      IF(TD(10).GE.TAKOFF) GO TO 250
      IF(Z.LT.4.) GO TO 245
      DZ=Z-4.
      J=J+2
      IVAL=IVAL+2
      GO TO 160
245   IF(TIMEX.LT.TYPRUN) GO TO 240
```

```
      GO TO 165
 250  WRITE(6,255)
 255  FORMAT(5X,* THE VEHICLE HAS TAKEN OFF*)
 260  WRITE(6,262) ENDRUN,T(10)
 262  FORMAT(3X,* END OF RUNWAY*,2F10.3)
C***********************************************************************
      TOTAL = X/TYPRUN
      WRITE(6,300) TOTAL
  300 FORMAT( * TOTAL NUMBER OF POINTS ON TAPE IS* F12.0)
 263  MGH = X
      IF(IFPLOT.EQ.1) GO TO 285
      XLONG = FLOAT(MGM)
      WRITE(6,265) NN,LL
 265  FORMAT(2I20)
      IF(NN.LE.1800.OR.LL.LE.1800) GO TO 266
      WRITE(6,267)
 267  FORMAT(3X,*THE ARRAYS CGACC OR PSACC OR PROF HAVE EXCEEDED
     1 THEIR DIMENSIONED SIZE*)
  266 CONTINUE
C266  CALL PLOTS(DATA,438)
C     CALL FACTOR (2.0)
C     CALL PLOT(0.0,-11.0,-3)
C     CALL PLOT(3.,.7,-3)
      TIME(NN+1) = 0.0
      TIME(NN+2) = 1.0
      TIME1(LL+1)  =0.0
      TIME1(LL+2) = 1.0
      CGACC(NN+1) = -1.0
      CGACC(NN+2) = 1.0
      PSACC(LL+1)= -1.0
      PSACC(LL+2) = 1.0
      CALL SCALE(PROF,10.,NN,1)
      PROF10 = PROF(NN+2) *10.
      IF(PROF10.GT.10.5) GO TO 270
      PROF(NN+2) = 6.0
      IF(NPTSS.GE.1000) GO TO 270
      DO 269 I=1,NN
 269  PROF(I)=PROF(I)+36.
 270  CALL AXIS(0.,0.,11HTIME (SEC.),-11,XLONG,0.0,TIME(NN+1),
     1TIME(NN+2),0)
      IXLONG = XLONG
      CALL PLOT (XLONG,1.1,3)
      CALL PLOT (0.,1.1,2)
      CALL SYMBOL (.1,.4,.105,8HDISTANCE,0.,8)
      CALL SYMBOL (.1,.2,.105,5HSPEED,0.,5)
      DO 275  I=1,IXLONG
      CALL NUMBER(STIME(I),.2,.105,SSPLOT(I),0.0,4HF4.0)
 275  CALL NUMBER(STIME(I),.4,.105,DDPLOT(I),0.0,4HF5.0)
      CALL PLOT (XLONG,1.5,3)
      CALL PLOT (0.,1.5,2)
      DO 280 I=1,ITT
 280  CALL SYMBOL(RMARK(I),-.1,.245,70,0.0,-1)
      CALL PLOT (XLONG,1.9,3)
      CALL PLOT (0.,1.9,2)
      CALL SYMBOL(4.,9.,.14,PLANE,0.,40)
      CALL SYMBOL(4.,8.,.14,SITE,0.,40)
      XLONG2=XLONG/2.
C     CALL SYMBOL(XLONG2,9.,.14,11HAFFDL -FYS-,0.,11)
```

```
C     CALL SYMBOL(XLONG2,8.,.14,10HWPAFB OHIO,0.,10)
      CALL PLOT(0.,1.5,-3)
      CALL AXIS(0.,-1.0,3HCGA,3,2.0,90.,CGACC(NN+1),CGACC(NN+2),-1)
      CALL NUMBER(0.4,-.4,.105,-.4,00.0,4HF4.1)
      CALL NUMBER(0.5,.4,.105,+.4,00.0,4HF4.1)
      CALL PLOT(0.,-1.0,-3)
      CALL LINE(TIME,CGACC,NN,1,0,0)
      CALL PLOT (XLONG,3.1,3)
      CALL PLOT (0.,3.1,2)
      CALL PLOT(0.,3.5,-3)
      CALL AXIS(0.,-1.0,3HPSA,3,2.0,90.,PSACC(LL+1),PSACC(LL+2),-1)
      CALL PLOT(0.,0.,3)
      CALL PLOT(XLONG,0.,2)
      CALL PLOT (XLONG,.4,3)
      CALL PLOT (-.1,.4,2)
      CALL NUMBER(0.5,.4,.105,+.4,00.0,4HF4.1)
      CALL NUMBER(0.4,-.5,.105,-.4,00.0,4HF4.1)
      CALL PLOT(0.,-1.0,-3)
      CALL LINE(TIME1,PSACC,LL,1,0,0)
      CALL PLOT(0.,-3.0,-3)
      CALL AXIS(-1.5,0.,15HELEVATION (IN.),15,10.0,90.0,PROF(NN+1),
     1PROF(NN+2),-1)
      CALL PLOT(0.,0.,-3)
      XPROF=.25+ABS(PROF(NN+1))/PROF(NN+2)
      CALL SYMBOL (2.,XPROF,.14,15HNOSE GEAR TRACK,0.,15)
      CALL LINE(TIME,PROF,NN,1,0,0)
      XSTOP=XLONG+5.
      CALL PLOT (XSTOP,0.,-3)
      WRITE(6,290)
      CALL PLOT(0.,0.,40)
C     CALL PLOTE
  285 STOP
  290 FORMAT(*S*)
      END
```

```
      SUBROUTINE TAYLOR(T,TD,TDD)
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
      COMMON/FLEX2/NFM,GM(15),OMEGA(15)
      COMMON/FLEX3/Q(15),QD(15),QDD(15)
      COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,MMI
      COMMON/X2/PACM,VOM,AAM,AMM,OAM
      COMMON/X3/PACN,VON,AAN,AMN,OAN
      COMMON/X4/SXM,SXN,SLM,SLN,TSM ,TSN
      COMMON/X5/CL,CD,AREA,THRUST
      COMMON/X6/Z,REACTM,REACTN,DX,NTRUN,SPEED
      COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN
      COMMON/X8/STROKM(20),PINDM(20),STROKN(20),PINDN(20),NSCM,NSCN
      COMMON/X9/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VELM,VELN
      COMMON/X10/ZPM,ZPN
      DIMENSION T(12), TD(12), TDD(12)
      REAL MCG,MM,MN,MMI
1     Z=Z+TD(10)*DX+TDD(10)*DX**2/2.
120   ZPM=AM+BM*Z+CM*Z**2+DM*Z**3
      ZPN=AN+BN*Z+CN*Z**2+DN*Z**3
       QTN=0.
      QTM=0.
      QTDN=0.
       QTDM=0.
       DO 130 I=1,NFM
       QTN=QTN+Q(I)*SINOSE(I)
      QTM=QTM+Q(I)*SIMAIN(I)
       QTDM=QTDM+QD(I)*SIMAIN(I)
130    QTDN=QTDN+QD(I)*SINOSE(I)
      XNOSE = (T(2) - B * T(8) - T(6)) +QTN
      XMAIN = (T(2) + A * T(8) - T(4)) +QTM
      VELM = TD(2) + A * TD(8) - TD(4) +QTDM
      VELN = TD(2) - B * TD(8) - TD(6) +QTDN
      IF(XMAIN.GE.0.) XMAIN=-.1
      IF(XNOSE.GE.0.) XNOSE=-.1
      IF(VELM.EQ.0.) VELM=-.1
      IF(VELN.EQ.0.) VELN=-.1
      XMLK=ABS(XMAIN)
      XNLK=ABS(XNOSE)
C  NOSE AND MAIN DAMPING COEFF
      CALL TLOCK(XMLK,SLOPEM,YCEPM,STROKM,PINDM,NSCM)
      CALL TLOCK(XNLK,SLOPEN,YCEPN,STROKN,PINDN,NSCN)
      AOM = OAM -((SLOPEM*XMLK+YCEPM)**2)*.78539
      AON = OAN -((SLOPEN*XNLK+ YCEPN)**2)*.78539
      CON=(.00008*(AMN**3.))/(2.*(.9*AON)**2)
      COM=(.00008*(AMM**3.))/(2.*(.9*AOM)**2)
C  NOSE AND MAIN STRUT PNEUMATIC FORCES
      SSM=(PAOM*VOM)/(((VOM/AAM)-XMLK))
      SSN=(PAON*VON)/(((VON/AAN)-XNLK))
      FTM = SXM * TSM * (T(4) - ZPM)
      FTN =SXN* TSN * (T(6) - ZPN)
      IF(FTM.GT.0.)FTM=0.
      IF(FTN.GT.0.)FTN=0.
      FSN=SXN*(-SSN+CON*VELN*ABS(VELN) )
      FSM=SXM*(-SSM +COM*VELM*ABS(VELM) )
      VLIFT =.001189*CL*AREA*(TD(10)*TD(10))
      DRAGA=VLIFT*CD/CL
      DRAGT =ABS(.025*FTM+.025*FTN)
      IF(NTRUN.EQ.1) GO TO 125
```

```
      IF(TD(10) .LT. SPEED) GO TO 125
      THRUST=DRAGA+DRAGT
  125 TDD(2) = (-FSN-FSM-MCG*386.+VLIFT)/MCG
      TDD(4)=(FSM-FTM-386.*SXM*MM)/(MM*SXM)
      TDD(6)=(FSN-FTN-MN*386.*SXN)/(MN*SXN)
      TDD(8) =-(FSM*A -FSN*B -DRAGT *(SLM+XMAIN))/MMI
      TDD(10) = (THRUST-DRAGA-DRAGT)/((MCG*12.))
      DO 200 I=1,NFM
  200  QDD(I)=-(SIMAIN(I)*(FSM-REACTM)+SINOSE(I)*(FSN-REACTN)
     1+.10*OMEGA(I)*QD(I)*GM(I)+OMEGA(I)**2*GM(I)*Q(I))/GM(I)
      DO 1001 I = 2,10,2
      T(I) = T(I) + TD(I)*DX + (TDD(I)*DX**2)/2.
 1001 TD(I) = TD(I) + TDD(I)*DX
      DO 1002 I=1,NFM
      Q(I)=Q(I)+QD(I)*DX+(QDD(I)*DX**2)/2.
 1002 QD(I)=QD(I)+QDD(I)*DX
      RETURN
      END
```

```
      SUBROUTINE IC(  ZCGI,ZMI,ZNI,THETAI)
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
      COMMON/FLEX2/NFM,GM(15),OMEGA(15)
      COMMON/FLEX3/Q(15),QD(15),QDD(15)
      COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,MMI
      COMMON/X2/PAOM,VOM,AAM,AHM,OAM
      COMMON/X3/PAON,VON,AAN,AHN,OAN
      COMMON/X4/SXM,SXN,SLM,SLN,TSM ,TSN
      COMMON/X9/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VELM,VELN
*************************************************************************
C THIS PROGRAM WILL FIND THE INITIAL CONDITIONS FOR  TAXI
C   FOR SXM MAIN AND SXN NOSE GEAR
C   ZMI= MAIN GEAR TIRE DEFLECTION 35 PERCENT
C   ZNI= NOSE GEAR TIRE DEFLECTION 35 PERCENT DEFLECTION
C   ZCGI= CG DEFLECTION
C   THETAI= PITCH ANGLE
C   XMAIN=  MAIN LANDING GEAR STATIC STROKE
C   XNOSE=  NOSE GEAR STATIC STROKE
*************************************************************************
      RM=W/(1.+A/B)
      RN=W-RM
      RM=RM/SXM
      RN=RN/SXN
      ZMI=-RM/TSM
      ZNI=-RN/TSN
      RSM=RM-WM
      RSN=RN-WN
      XNOSE=+PAON*VON/RSN-VON/AAN
      XMAIN=+PAOM*VOM/RSM-VOM/AAM
      THETAI=-(XNOSE+ZNI-(XMAIN+ZMI))/(B+A)
      ZCGI=XMAIN-A*THETAI+ZMI
       DO 10 I=1,NFM
       QD(I)=0.
 10   Q(I)=0.
      RETURN
      END
```

```
SUBROUTINE CCEFF (Y,  A,B,C,D)
DIMENSION Y(4)
A=Y(2)
B=Y(1)
C=(96.*Y(1)+56.*Y(2)-64.*Y(3)+8.*Y(4))/(-128.)
D=(-16.*Y(1)-12.*Y(2)+16.*Y(3)-4.*Y(4))/(-128.)
RETURN
END
```

```
      SUBROUTINE TLOOK (X,SLOPE,YCEPT,S,P,N)
      DIMENSION S(30),P(30)
C
C     THIS IS A 2 DIMENSIONAL TABLE LOOK UP ROUTINE
C     WITH LINEAR INTERPOLATION
C
C   X  IS THE CURRENT VALUE OF STROKE
C   SLOPE AND YCEPT ARE CALCULATED AND RETURNED
C   S AND P  MAKE UP THE TABLE
C   N IS THE NUMBER OF VALUES IN THE TABLE
      DO 1 I=1,N
      IF (X.GE.S(I).AND.X.LT.S(I+1))GO TO 2
 1     CONTINUE
 2    SLOPE=(P(I+1)-P(I))/(S(I+1)-S(I)+.01)
      YCEPT=P(I)-SLOPE*S(I)
      RETURN
      END
```

```
      PROGRAM TAXI(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE3,TAPE2,
     1 TAPE7)
*********************************************************************
C  THIS IS THE TAXI MAIN ROUTINE FOR A C-5A AIRCRAFT SIMULATION
*********************************************************************
************************************************************************
************************************************************************
************************************************************************
C     ****THIS DECK IS FOR THE C-5A AIRCRAFT ONLY****
C  THIS PROGRAM WILL PERFORM A SYMMETRIC
C  DYNAMIC TAXI ANALYSIS ON A FLEXIBLE
C  VEHICLE TRAVERSING A GIVEN RIGID RUNWAY
C  PROFILE.
************************************************************************
************************************************************************
************************************************************************
      COMMON/FLEX1/SIMAIN1(15),SIMAIN2(15),SINOSE(15),SICG(15)
     1,SITAIL(15),SIPS(15)
      COMMON/FLEX2/NFM,GM(15),OMEGA(15)
      COMMON/FLEX3/Q(15),QD(15),QDD(15)
      COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,C,MMI
      COMMON/X2/PACM,VOM,AAM,AHM,OAM
      COMMON/X3/PACN,VON,AAN,AHN,OAN
      COMMON/X4/SXM,SXN,SLM,SLN,TSM,TSN
      COMMON/X5/CL,CD,AREA,THRUST
      COMMON/X6/Z,REACTM1,REACTN,REACTM2,DX,NTRUN,SPEED
      COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN,AMA,BMA,CMA,DMA
      COMMON/X8/STROKM(20),PINCM(20),STROKN(20),PINDN(20),NSCM,NSCN
      COMMON/X9/FSM1,FSM2,FSN,FTM1,FTM2,FTN,XMAIN1,XMAIN2,XNOSE,
     1VELM1,VELM2,VELN
      COMMON/X10/ZPM,ZPMA,ZPN
      DIMENSION PLANE(8),SITE(8)
      DIMENSION T(18), TD(18), TDD(18)
      DIMENSION YP(4),YPN(4),DATA(438),YPA(4)
      DIMENSION ELEV(7500)
      DIMENSION CGACC(1800), TIME(1800), PSACC(1800), TIME1(1800)
      DIMENSION PROF(1800),RMARK(20)
      DIMENSION SSPLOT(300), STIME(300),DDPLOT(300)
      REAL MCG,MM,MN,MMI
      CALL PLOTS(100.,DUM,3)
      PSA=0.0
      CGOUT=0.0
      MDR=0.
      X=0.
      LLL = 1
      LL = 0
      STORE1 = 0.
      STORE2 = 0.
      STORE3 = 0.
      STORE4 = 0.
      NN = 0
      II = 0
      FP = 1.0
      M = 1
      ITT = 0
************************************************************************
C        READ AND PRINT INPUT DATA
************************************************************************
```

```
C    W=VEHICLE WEIGHT AT CG (POUNDS)
C    A=DISTANCE MAIN GEAR TO CG (INCHES)
C    B=DISTANCE NOSE GEAR TO CG (INCHES)
C        C = DISTANCE FROM FRONT MAIN GEAR TO CG
C        1 CORESPONDS TO REAR MAIN GEAR
C        2 CORESPONDS TO FRONT MAIN GEAR
C MMI=MASS MOMENT OF INERTIA (LB IN SEC SQ)
C   PLANE= AIRPLANE BEING SIMULATED AND  GROSS WEIGHT
C   PSARM = DISTANCE OF PILOT STATION TO CG
C       TAILRM = DISTANCE OF TAIL STATION TO CG
C   TAKOFF= TAKE-OFF SPEED (FEET/SEC)
C SPEED =INITIAL  VEL  OF  AIRPLANE
C   THURST= TOTAL AIRPLANE THRUST
C   CL=LIFT COEFF.
C   AREA=WING AREA
C   CD=DRAG COEFF.
C   WM=WEIGHT OF MAIN GEAR  (EACH)
C   WN=WEIGHT OF NOSE GEAR
C   SXM= NUMBER OF MAIN GEAR STRUTS
C    SXN= NUMBER OF NOSE GEAR STRUTS
C AHN  HYDRAULIC PISTON AREA NOSE SQ INCHES
C AAN  PNEUMATIC PISTON AREA NOSE SQ INCHES
C AHM  HYDRAULIC PISTON AREA MAIN SQ INCHES
C AAM  PNEUMATIC PISTON AREA MAIN SQ INCHES
C PAON NOSE STRUT PRELOAD PRESSURE  PSI
C PAOM MAIN STRUT PRELOAD PRESSURE  PSI
C VON  NOSE STRUT INITIAL VOLUME CU. IN.
C VOM  MAIN STRUT INITIAL VOLUME CU. IN.
C CAM  ORIFACE AREA MAIN
C CAN  ORIFACE AREA NOSE
C SLM=MAIN GEAR STRUT LENGTH UNLOADED INCHES
C       DISTANCE FROM CL OF AXLE TO CG LINE
C SLN=NOSE GEAR STRUT LENGTH UNLOADED INCHES
C       DISTANCE FROM CL OF AXLE TO CG LINE
C   TSM     MAIN TIRE SPRING CONSTANT PER STRUT
C   TSN     NOSE TIRE SPRING CONSTANT PER STRUT
C   DX=TIME STEP SIZE
C   READ METERING PIN DESCRIPTION STARTING AT ZERO STROKE
C   NSCN=# OF METERING PIN CHANGES NOSE GEAR
C   NSCM=# OF METERING PIN CHANGES MAIN GEAR
C   NFM = NUMBER OF FLEXIBLE MODES
C   SIXXXX(I) = MODE SHAPE DEFLECTION (NON DIM.)
C   GM(I) = GENERALIZED MASS (POUNDS-SEC SQ/IN)
C   OMEGA (I) = MODAL FREQUENCIES (RAD/SEC)
      READ (5,1) PLANE
 1    FORMAT(8A10)
      READ(5,5) W, A, B, C, MMI
5     FORMAT(4F10.1,F12.0)
      READ(5,10) PSARM,TAILRM
 10   FORMAT(2F10.2)
      READ(5,15) SPEED,THRUST,TAKOFF
 15   FORMAT(3F10.3)
      READ(5,20) CL,AREA,CD
 20   FORMAT(3F10.4)
      READ(5,25) WM,WN,SXM,SXN
 25   FORMAT(4F10.2)
      READ(5,30) AHN,AAN,AHM,AAM
 30   FORMAT(4F10.5)
```

```
      READ(5,35) PACN,PAOM,VON,VOM,OAM,OAN
35    FORMAT(6F10.5)
      READ(5,40) SLM,SLN
40    FORMAT(2F10.3)
      READ(5,45) TSM ,TSN
45    FORMAT(2F10.1)
      READ(5,50)DX
      READ(5,51)IFPLOT
50    FORMAT(F10.3)
      READ(5,51) NSCN
51    FORMAT(I5)
      READ(5,52) (STROKN(I),PINDN(I),I=1,NSCN)
52    FORMAT(2(F10.3))
      READ(5,51)NSCM
      READ(5,52) (STROKM(I),PINDM(I),I=1,NSCM)
      READ(5,51) NFM
      READ(5,53) (SIMAIN1(I),SIMAIN2(I),SINOSE(I),SICG(I),SITAIL(I),
     1SIPS(I), I=1,NFM)
53    FORMAT(6F10.3)
      READ(5,54) (CM(I),OMEGA(I),I=1,NFM)
54    FORMAT(F15.2,F10.3)
      MM=WM/386.
      MN=WN/386.
      MCG=W/386.
      TYPRUN = .01
      NTRUN= 1
      IF(SPEED .GT. 5.) 56,57
   56 TYPRUN = .01
      NTRUN = 2
   57 WRITE(6,55)
55    FORMAT(1H1,46X,*******************************************)
      WRITE(6,60)
60    FORMAT(46X,46H****************** INPUT DATA ******************)
      WRITE(6,61)
61    FORMAT(///1X,41H********* GENERAL AIRCRAFT DATA *********)
      WRITE(6,62)PLANE
62    FORMAT(//,1X,8A10)
      WRITE(6,65) W,WM,WN,A,B,C,MMI
65    FORMAT(///,5X,*W=*,F10.1,5X,*WM=*,F10.2,5X,*WN=*,F10.2,5X,
     1*A=*,F10.3,5X,*B=*,F10.3,5X,*C=*,F10.3,5X,*MMI=*,F12.0)
      WRITE(6,66) SXM,SXN,SLM,SLN,PSARM,TAILRM
66    FORMAT(//,5X,*SXM=*,F8.1,5X,*SXN=*,F9.1,5X,*SLM=*,F9.1,5X,
     1*SLN=*,F8.1,5X,*PSARM *,F7.1,4X,*TAILRM=*,F7.1)
      WRITE(6,70) AAM,AHM,PAOM,VOM,OAM,TSM
70    FORMAT(//,5X,*AAM=*,F8.2,5X,*AHM=*,F8.2,6X,*PAOM=*,F9.2,4X,
     1*VOM=*,F8.2,5X,*OAM=*,F8.2,5X,*TSM =*,F10.2)
      WRITE(6,74) AAN,AHN,PAON,VON,OAN,TSN
74    FORMAT(//,5X,*AAN=*,F8.2,5X,*AHN=*,F8.2,6X,*PAON=*,F9.2,4X,
     1*VON=*,F8.2,5X,*OAN=*,F8.2,5X,*TSN =*,F10.2)
      WRITE(6,75) CL,CD,AREA,SPEED,THRUST,TAKOFF
75    FORMAT(//,5X,*CL=*,F9.3,5X,*CD=*,F9.3,6X,*AREA=*,F8.2,5X,
     1*SPEED=*,F7.1,4X,*THRUST=*,F7.0,3X,*TAKOFF=*,F10.2)
      WRITE(6,76) (STROKN(I),PINDN(I),I=1,NSCN)
76    FORMAT(//,3X,*STROKE NOSE    PIN DIAMETER    *//,2(3X,F10.3))
      WRITE(6,77) (STROKM(I),PINDM(I),I=1,NSCM)
77    FORMAT(//,3X,*STROKE MAIN    PIN DIAMETER    *//,2(3X,F10.3))
      WRITE(6,80)
80    FORMAT(1H1,1X,*MODE   SIPS    SINOSE     SICG    SIMAIN1    SIMAIN2
```

```
     1SITAIL  CMEGA    GEN. MASS*)
      DO 85  I=1,NFM
 85   WRITE(6,90 )(I,SIPS(I),SINCSE(I),SICG(I),SIMAIN1(I),SIMAIN2(I),
     1SITAIL(I),OMEGA(I),GM(I))
 90    FORMAT(//,    2X,I2,7(F7.2,2X),F10.1)
C ZMI =INITIAL MAIN GEAR POSITION INCHES
      WRITE(6,95)
 95   FORMAT(///,46X,40H********* INTIAL CONDITIONS ************)
C ZNI =INITIAL NOSE GEAR POSITION INCHES
C ZCGI=INITIAL C.G. POSITION INCHES
C THETAI=INITIAL PITCH ANGLE DEGREES
C   THE ABOVE PARAMETERS ARE CALCULATED IN SUBROUTINE IC
      CALL IC(ZCGI,ZMI1,ZMI2,ZNI,THETAI)
      WRITE(6,105)ZMI1,ZMI2,ZNI,THETAI,ZCGI
 105  FORMAT(/,5X,*ZMI1=*,F7.3,5X,*ZMI2=*,F7.3,6X,*ZNI=*,F7.3,7X,
     1*THETAI=*,F7.3,6X,*ZCGI=*,F10.3)
      REACTN=(ZNI*TSN )*SXN
      REACTM1 = (ZMI1*TSM ) *SXM/2.
      REACTM2= (ZMI2*TSM ) *SXM/2.
      WRITE(6,106)XMAIN1,XMAIN2,XNOSE,REACTM1,REACTM2,REACTN
 106  FORMAT(/5X,*XMAIN1=*,F7.2,3X,*XMAIN2=*,F7.2,4X,*XNOSE=*,F7.2,5X,
     1*REACTM1=*,F10.0,2X,*REACTM2=*,F10.0,2X,*REACTN=*,F10.0)
*************************************************************************
C READ RUNWAY PROFILE DATA (ELEV)
C   SITE= RUNWAY PROFILE AND DIRECTION
C  NPTSS== OF RUNWAY ELEVATION DATA POINTS
      WRITE (6,111)
 111  FORMAT(*T*)
      DO 112 I=1,50
 112  ELEV(I)=0.0
      READ(2,1) SITE
      READ(2,116) NPTSS
      NPTSS=NPTSS+50
  116 FORMAT(I5)
      LD=51
 117  LSD = LD + 9
      READ(2,118) (ELEV(I),I=LD,LSD)
 118  FORMAT(10F7.3)
      N10=LD
      IF(LSD.GE.NPTSS) GO TO 120
      LD=LD+10
      GO TO 117
 120  ELEV1=ELEV(51)
      DO 125 I=51,N10
  125 ELEV(I) = ELEV(I)-ELEV1
      CALL RETURNS(2)
      DISTAN=0.
      LSD=LSD-90
      SLP=(LSD-50)*2
      SLP=ELEV(LSD)/SLP
      DO 126 I=51 ,N10
      ELEV(I)=ELEV(I)-SLP*DISTAN
 126  DISTAN=DISTAN+2.
      IVAL=(A+B)/24.
      VALA = (A+C)/24.
      IVALA=VALA
      WRITE(6,130)
 130  FORMAT(1H1,5X,*  RUNWAY PROFILE DATA NORMALIZED (SLOPE REMOVED)*
```

```
  150X,*FEET DOWN THE RUNWAY*)
      WRITE(6,1) SITE
      LD1=1
 135  LSD1 = LD1 + 9
      LPRIN = LSD1 * 2
      WRITE(6,140)  (ELEV(I),I=LD1,LSD1),LPRIN
 140  FORMAT(3X,10F10.5,10X,I8)
      LD1=LD1+10
      IF(LD1.GE.N10) GO TO 145
      GO TC 135
 145  WRITE(6,150) LD1
 150  FORMAT(42H********** END RUNWAY DATA ********** LD1=,I5)
      WRITE(7,1)SITE
      ENDRUN = NPTSS*2
      MRM=(ENDRUN-100.)/1000.
      RM=(((ENDRUN-100.)-FLOAT(MRM*1000))/2.)+1100.
      ENDRUN=ENDRUN-90.
      T(2) =ZCGI
      TD(2) = 0.
      T(4) = ZPI1
      TD(4) = 0.
      T(6) = ZNI
      TD(6) = C.
      T(8) = THETAI
      TD(8) = 0.
      T(10) = C.
      TD(10)=SPEED
      T(12) = ZMI2
      TD(12) = 0.0
      T(14)= TD(14) =TDD(14) = 0.0
      T(16)= TC(16) =TDD(16) = 0.0
      T(18)= TC(18) =TDD(18) = 0.0
      WRITE(6,155)
 155   FORMAT(1H1,7X,*    XMAIN1         XNOSE          FSM1              FSN
     1    TAILAC          SPEED        DIST.         CGACC          PSA         TIM
     2E*)
       DZ=0.
       ZPM=0.
       ZPN=0.
       ZDOT=0.
       ZNDOT=0.
       ZPMA = 0.0
       ZADOT=0.
       J=1
 160   YP(1) = ZDOT
       YP(2)=ELEV(J)
       YP(3)=ELEV(J+1)
       YP(4)=ELEV(J+2)
       YPN(1)=ZNDOT
       YPN(2)=ELEV(IVAL)
       YPN(3)=ELEV(IVAL+1)
       YPN(4)=ELEV(IVAL+2)
        YPA(1)=ZADOT
       YPA(2) = ELEV(IVALA)
       YPA(3) = ELEV(IVALA+1)
       YPA(4) = ELEV(IVALA+2)
       Z=DZ
       CALL COEFF (YPN,AN,BN,CN DN)
```

```
      CALL COEFF (YP,AM,BM,CM,DM)
      CALL COEFF(YPA, AMA,BMA,CMA,DMA)
      ZDOT=BM
      ZNDOT=BN
       ZADOT=BMA
      IF(M.GT.1) GO TO 245
      M = M + 1
 165    WRITE(6,170) XMAIN1,XNOSE,FSM1,FSN,TAILAC,TO(10),T(10),
     1CGOUT ,PSA,X
      WRITE(7,900) TAILAC,CGOUT,PSA
 900  FORMAT(3X,F10.3)
      TIMEX=0.
 170   FORMAT(3X,2(3X,F10.3),2(3X,F10.0),5(3X,F10.3),2X,F6.2)
***********************************************************************
      IF(IFPLOT.EQ.1) GO TO 230
      IF(ABS(CGOUT ).LE.ABS(STORE2).AND.ABS(STORE2).GE.ABS(STORE1))
     1GO TO 180
 175  STORE1 = STORE2
      STORE2 = CGOUT
      GO TO 190
 180  IF(X-TIME(NN).GT..08) GO TO 185
      IF(ABS(STORE2).GT..30000) GO TO 185
      GO TO 175
 185  NN = NN + 1
      CGACC(NN) = STORE2
      PROF(NN) = ZPN
      TIME(NN) = X - 10. * DX
      IF(TIME(NN).LT.0.) TIME(NN) = .01
      STORE1 = STORE2
      STORE2 = CGOUT
 190  IF(ABS(PSA).LE.ABS(STORE4).AND.ABS(STORE4).GE.ABS(STORE3))
     1GO TO 205
 200  STORE3 = STORE4
      STORE4 = PSA
      GO TO 215
 205  IF(X-TIME1(LL).GT..08) GO TO 210
      IF(ABS(STORE4).GT..32) GO TO 210
      GO TO 200
 210  LL = LL + 1
      PSACC(LL) = STORE4
      TIME1(LL)=X - 10*DX
      IF(TIME1(LL).LE.0.) TIME1(LL) = .001
      STORE3 = STORE4
      STORE4 = PSA
 215  IF(ABS(T(10)-RM).LT.5.0) GO TO 220
      GO TO 225
 220  II = II + 1
      RMARK(II) = X
      RM = RM + 1000.
      ITT = II
 225  IF(ABS(X-PP).GT..005)GO TO 230
      SSPLOT(LLL) = TO(10)
      STIME(LLL) = X
      CDPLOT(LLL) = T(10)
      LLL = LLL + 1
      PP = PP + 1.0
***********************************************************************
 230  IF(MDR.LE.60.) GO TO 235
```

```
      HOR=0.
      WRITE(6,155)
 235  HOR = HOR + 1.
 240  X = X + DX
      CALL TAYLOR(T,TO,TDD)
      IF(T(10).GE.ENDRUN) GO TO 260
      IF(X.GE.300.) GO TO 263
      TIMEX=TIMEX+DX
       QDDCG=0.
      QDDPS=0.
      QDDTAL=0.
      DO 241 I=1,NFM
       QDDTAL=QDDTAL+QDD(I)*SITAIL(I)
      QDDCG=QDDCG+QDD(I)*SICG(I)
 241   QDDPS=QDDPS+QDD(I)*SIPS(I)
      TAILAC=(TDD(2)+TAILRM*TDD(8))/386. +QDDTAL/386.
      PSA=(TDD(2)-PSARM*TDD(8))/386.      +QDDPS/386.
      CGOUT=TDD(2)/386.    +QDDCG/386.
      IF(TD(10).GE.TAKOFF) GO TO 250
      IF(Z.LT.4.) GO TO 245
      DZ=Z-4.
      J=J+2
      IVAL=IVAL+2
      IVALA = IVALA + 2
      GO TO 160
 245  IF(TIMEX.LT.TYPRUN) GO TO 240
      GO TO 165
 250  WRITE(6,255)
 255  FORMAT(5X,* THE VEHICLE HAS TAKEN OFF*)
 260  WRITE(6,262) ENDRUN,T(10)
 262  FORMAT(3X,* END OF RUNWAY*,2F10.3)
**********************************************************************
      TOTAL = X/.01
      WRITE(6,300) TOTAL
  300 FORMAT(* TOTAL NUMBER OF POINTS ON TAPE IS*F12.0)
 263  MGM = X
      IF(IFPLOT.EQ.1) GO TO 285
      XLONG = FLOAT(MGM)
      WRITE(6,265) NN,LL
 265  FORMAT(2I20)
      IF(NN.LE.1800.OR.LL.LE.1800) GO TO 266
      WRITE(6,267)
 267  FORMAT(3X,*THE ARRAYS CGACC OR PSACC OR PROF HAVE EXCEEDED
     1 THEIR DIMENSIONED SIZE*)
  266 CONTINUE
C266  CALL PLOTS(DATA,438)
C     CALL FACTOR (2.0)
C     CALL PLOT(0.0,-11.0,-3)
C     CALL PLOT(3.,.7,-3)
      TIME(NN+1) = 0.0
      TIME(NN+2) = 1.0
      TIME1(LL+1)  =0.0
      TIME1(LL+2) = 1.0
      CGACC(NN+1) = -1.0
      CGACC(NN+2) = 1.0
      PSACC(LL+1)= -1.0
      PSACC(LL+2) = 1.0
      CALL SCALE(PROF,10.,NN,1)
```

```
      PROF10 = PROF(NN+2) *10.
      IF(PROF10.GT.10.5) GO TO 270
      PROF(NN+2) = 6.0
      IF(NPTSS.GE.1000) GO TO 270
      DO 269 I=1,NN
  269 PROF(I)=PROF(I)+36.
  270 CALL AXIS(0.,0.,11HTIME (SEC.),-11,XLONG,0.0,TIME(NN+1),
     1TIME(NN+2),3)
      IXLONG = XLONG
      CALL PLOT (XLONG,1.1
      CALL PLOT (0.,1.1,2)
      CALL SYMBOL (.1,.4,.105,8HDISTANCE,0.,8)
      CALL SYMBOL (.1,.2,.105,5HSPEED,0.,5)
      DO 275  I=1,IXLONG
      CALL NUMBER(STIME(I),.2,.105,SSPLOT(I),0.0,4HF4.0)
  275 CALL NUMBER(STIME(I),.4,.105,DDPLOT(I),0.0,4HF5.0)
      CALL PLOT (XLONG,1.5,3)
      CALL PLOT (0.,1.5,2)
      DO 280 I=1,ITT
  280 CALL SYMBOL(RMARK(I),-.1,.245,70,0.0,-1)
      CALL PLOT (XLONG,1.9,3)
      CALL PLOT (0.,1.9,2)
      CALL SYMBOL(4.,9.,.14,PLANE,0.,40)
      CALL SYMBOL(4.,8.,.14,SITE,0.,40)
      XLONG2=XLONG/2.
      CALL PLOT(0.,1.5,-3)
      CALL AXIS(0.,-1.,3HCGA,3,2.0,90.,CGACC(NN+1),CGACC(NN+2),-1)
      CALL NUMBER(0.4,-.4,.105,-.4,00.0,4HF4.1)
      CALL NUMBER(0.5,+.4,.105,+.4,00.0,4HF4.1)
      CALL PLOT(0.,-1.0,-3)
      CALL LINE(TIME,CGACC,NN,1,0,74)
      CALL PLOT (XLONG,3.1,3)
      CALL PLOT (0.,3.1,2)
      CALL PLOT(0.,3.5,-3)
      CALL AXIS(0.,-1.,3HPSA,3,2.0,90.,PSACC(LL+1),PSACC(LL+2),-1)
      CALL PLOT(0.,0.,3)
      CALL PLOT(XLONG,0.,2)
      CALL PLOT (XLONG,.4,3)
      CALL PLOT (-.1,.4,2)
      CALL NUMBER(0.5,.4,.105,+.4,00.0,4HF4.1)
      CALL NUMBER(0.4,-.5,.105,-.4,00.0,4HF4.1)
      CALL PLOT(0.,-1.0,-3)
      CALL LINE(TIME1,PSACC,LL,1,0, 0)
      CALL PLOT(0.,-3.0,-3)
      CALL AXIS(-1.5,0.,15HELEVATION (IN.),15,10.0,90.0,PROF(NN+1),
     1PROF(NN+2),-1)
      CALL PLOT(0.,0.,-3)
      XPROF=.25+ABS(PROF(NN+1))/PROF(NN+2)
      CALL SYMBOL (2.,XPROF,.14,15HNOSE GEAR TRACK,0.,15)
      CALL LINE(TIME,PROF,NN,1,0, 0)
      XSTOP=XLONG+5.
      CALL PLOT (XSTOP,0.,-3)
      WRITE(6,290)
      CALL PLOT(0.,0.,40)
C     CALL PLOTE
  285 STOP
  290 FORMAT(*S*)
      END
```

```
      SUBROUTINE TAYLOR(T,TD,TDD)
      COMMCN/FLEX1/SIMAIN1(15),SIMAIN2(15),SINOSE(15),SICG(15)
     1,SITAIL(15),SIPS(15)
      COMMCN/FLEX2/NFM,GM(15),OMEGA(15)
      COMMON/FLEX3/Q(15),QD(15),QDD(15)
      COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,C,MMI
      COMMON/X2/PACM,VOM,AAM,AHM,OAM
      COMMON/X3/PACN,VON,AAN,AHN,OAN
      COMMON/X6/Z,REACTM1,REACTN,REACTM2,DX,NTRUN,SPEEC
      COMMON/X5/CL,CD,AREA,THRUST
      COMMON/X4/SXM,SXN,SLM,SLN,TSM,TSN
      CCMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN,AMA,BMA,CMA,DMA
      COMMON/X8/STROKM(20),PINDM(20),STROKN(20),PINDN(20),NSCM,NSCN
      COMMON/X9/FSM1,FSM2,FSN,FTM1,FTM2,FTN,XMAIN1,XMAIN2,XNOSE,
     1VELM1,VELM2,VELN
      COMMCN/X10/ZPM,ZPMA,ZPN
      DIMENSION T(18), TD(18), TDD(18)
      REAL MCG,MM,MN,MMI
*********************************************************************
C  THIS THE TAYLOR SUBROUTINE FOR A C-5A AIRCRAFT SIMULATION
*********************************************************************
1     Z=Z+TD(10)*DX+TDD(10)*DX**2/2.
      ZPN=AN+BN*Z+CN*Z**2+DN*Z**3
      ZPM=AM+BM*Z+CM*Z**2+DM*Z**3
        ZPMA=AMA+BMA*Z+CMA*Z**2+DMA*Z**3
       QTN=0.
      QTM1= 0.0
      QTM2=0.0
      QTON=0.
      QTOM1=0.0
      QTOM2=0.0
       DO 10 I=1,NFM
       QTN=QTN+Q(I)*SINOSE(I)
      QTM1= QTM1 +Q(I)*SIMAIN1(I)
      QTM2= QTM2 +Q(I)*SIMAIN2(I)
      QTOM1= QTOM1 + QD(I)* SIMAIN1(I)
      QTOM2= QTOM2 + QD(I)* SIMAIN2(I)
10     QTON=QTON+QD(I)*SINOSE(I)
      XNOSE = (T(2) - B * T(8) - T(6)) +QTN
      XMAIN1= (T(2) + A*T(8)-T(4)) + QTM1
      XMAIN2= (T(2) - C*T(8)-T(12)) +QTM2
      VELN = TD(2) - B * TD(8) - TD(6) +QTON
      VELM1 =  TD(2)+ A*TD(8)-TD(4) +QTOM1
      VELM2 =  TD(2)- C*TD(8)-TD(12) +QTOM2
C
C CALCULATE SPRING AND DAMPING COEFFICIENTS
C
      IF(XNOSE.GT.0.) XNOSE = -.001
      IF(XMAIN1.GT.0.) XMAIN1 = -.001
      IF(XMAIN2.GT.0.) XMAIN2 = -.001
      IF(VELN.EQ.0.) VELN=.001
      IF(VELM1.EQ..00) VELM1=.001
      IF(VELM2.EQ.0.) VELM2=0.001
      VELN =VELN - TD(14)
      VELM1=VELM1- TD(18)
      VELM2=VELM2- TD(16)
      XNLK=ABS(XNOSE)
      XMLK1 = ABS(XMAIN1)
```

```
      XMLK2 = ABS(XMAIN2)
      CALL TLOCK(XNLK,SLOPEN,YCEPN,STROKN,PINON,NSCN)
      CALL TLOCK(XMLK1,SLOPEM1,YCEPM1,STROKM,PINOM,NSCM)
      CALL TLOCK(XMLK2,SLOPEM2,YCEPM2,STROKM,PINOM,NSCM)
      AON = SLOPEN*XNLK +YCEPN
      AOM1 = SLOPEM1*XMLK1 +YCEPM1
      AOM2 = SLOPEM2*XMLK2 +YCEPM2
      CON=(.00008*(AHN**3.)     )       /(2.*(.9*AON)**2)
      COM1= (.00008*(AHM**3.))/(2.*(.9*AOM1)**2)
      COM2= (.00008*(AHM**3.))/(2.*(.9*AOM2)**2)
      SSN=(PAON*VON)/(((VON/AAN)-XNLK))
      SSM1= (PAOM*VOM)/(((VOM/AAM)-XMLK1))
      SSM2= (PAOM*VOM)/(((VOM/AAM)-XMLK2))
      FTN =SXN* TSN * (T(6) - ZPN)
      FTM1 = (SXM/2.)*TSM*(T(4)-ZPM)
      FTM2 = (SXM/2.)*TSM*(T(12)-ZPMA)
      IF(FTN.GT.0.)FTN=0.
      IF(FTM1.GT.0.) FTM1=0.0
      IF(FTM2.GT.0.) FTM2=0.0
      IF(T(14).LT.0.000) SSN = (2937242.)/((28.38)-XNLK)
      IF(T(16).LT.0.000) SSM2 = (5124326.59)/((37.893)-XMLK2)
      IF(T(18).LT.0.000) SSM1 = (5124326.96)/((37.89)-XMLK1)
      FSN = SXN*(-SSN+CON*VELN*ABS(VELN))
      FSM1 = (SXM /2.0) * (-SSM1 + COM1*VELM1*ABS(VELM1))
      FSM2 = (SXM /2.0) * (-SSM2 + COM2*VELM2*ABS(VELM2))
      VLIFT =.001189*CL*AREA*(TD(10)*TD(10))
      DRAGA=VLIFT*CD/CL
      DRAGT =ABS(.025*FTM1 +.025*FTM2 +.025*FTN)
      IF(NTRUN .EQ. 1) GO TO 125
      IF(TD(10) .LT. SPEED) GO TO 125
      THRUST = DRAGA + DRAGT
C      SECONDARY PISTON CALCULATIONS
  125 CON = .5
      COM1 = .5
      COM2 = .5
      IF(TD(14).GT.0.0) CON = 5.0
      IF(TD(16).GT.0.0) COM2 = 5.0
      IF(TD(18).GT.0.0) COM1 = 5.0
      F2N  = 2733218./(18.43-ABS(T(14))) -20.*TD(14)-CON*TD(14)*ABS(
     1TD(14))
      F2M2 = 4643757./(26.21-ABS(T(16))) -20.*TD(16)-COM2*TD(16)*ABS(
     1TD(16))
      F2M1 = 4643757./(26.21-ABS(T(18))) - 20.*TD(18)-COM1*TD(18)*ABS(
     1TD(18))
      FSTN = FSN* .803 + F2N
      FST1 = (FSM1/2.)*.708 + F2M1
      FST2 = (FSM2/2.) *.708 + F2M2
      TDD(2)=(-FSN-FSM1-FSM2-MCG*386.+VLIFT)/MCG
      TDD(4) = (FSM1-FTM1-MM*772.)/(MM*2.)
      TDD(6) = (FSN-FTN-MN*386.)/MN
      TDD(8) =-(FSM1*A -FSM2*C -FSN*B -DRAGT*(SLM+XMAIN1))/MMI
      TDD(10) = (THRUST-DRAGA-DRAGT       )/((MCG+MM+MN) *12.)
      TDD(12)= (FSM2-FTM2-MM*772.)/(MM*2.)
      TDD(14) = FSTN/.259
```

```
      TDD(16) = FST2/.259
      TDD(18) = FST1/.259
      DO 20  I=1,NFM
20    QDD(I) =-(SIMAIN1(I)*(FSM1-REACTM1) +SIMAIN2(I)*(FSM2-REACTM2)
     1+(FSN-REACTN)*SINOSE(I)+.2*OMEGA(I)*GM(I)*QD(I)+OMEGA(I)**2*2*
     2GM(I)*Q(I))/GM(I)
      DX = .001
      IF(FSTN.LT.8000..OR.T(14).LT.0.0) DX = .00005
      IF(FST1.LT.8000..OR.T(18).LT.0.0) DX = .00005
      IF(FST2.LT.8000..OR.T(16).LT.0.0) DX = .00005
      IF(ABS(TD(14)).GT..001) DX = .00005
      IF(ABS(TD(16)).GT..001) DX = .00005
      IF(ABS(TD(18)).GT..001) DX = .00005
      DO 30 I=2,18,2
      T(I) = T(I) + TD(I)*DX + (TDD(I)*DX**2)/2.
30    TD(I) = TD(I) + TDD(I)*DX
      IF(T(14).GE.-.0001.AND.TD(14).GE.0.000) T(14)=TD(14)=TDD(14)=0.0
      IF(T(16).GE.-.0001.AND.TD(16).GE.0.000) T(16)=TD(16)=TDD(16)=0.0
      IF(T(18).GE.-.0001.AND.TD(18).GE.0.000) T(18)=TD(18)=TDD(18)=0.0
      DO 40 I=1,NFM
      Q(I)=Q(I)+QD(I)*DX+(QDD(I)*DX**2)/2.
40    QD(I)=QD(I)+QDD(I)*DX
      RETURN
      END
```

```
      SUBROUTINE IC(ZCGI,ZMI1,ZMI2,ZNI,THETAI)
      COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,C,MMI
      COMMON/X2/PAOM,VOM,AAM,AHM,OAM
      COMMON/X3/PAON,VON,AAN,AHN,OAN
      COMMON/X4/SXM,SXN,SLM,SLN,TSM,TSN
      COMMON/X6/Z,REACTM1,REACTN,REACTM2,DX,NTRUN
      COMMON/X9/FSM1,FSM2,FSN,FTM1,FTM2,FTN,XMAIN1,XMAIN2,XNOSE,
     1VELM1,VELM2,VELN
*********************************************************************
C  THIS IS THE IC SUBROUTINE FOR A C-5A AIRCRAFT SIMULATION
*********************************************************************
*************************************************************************
C THIS PROGRAM WILL FIND THE INITIAL CONDITIONS FOR  TAXI
C  FOR SXM MAIN AND SXN NOSE GEAR
C  ZMI= MAIN GEAR TIRE DEFLECTION 35 PERCENT
C  ZNI= NOSE GEAR TIRE DEFLECTION 35 PERCENT DEFLECTION
C  ZCGI= CG DEFLECTION
C  THETAI= PITCH ANGLE
C  XMAIN=  MAIN LANDING GEAR STATIC STROKE
C  XNOSE=  NOSE GEAR STATIC STROKE
*************************************************************************
1     RM1 = 80000.
10    RM1=RM1 +50.
      RM2 = (RM1*(A+B)- W*B)/(C-B)
      RN = W-RM1 -RM2
      RM1T = RM1/2.
      RM2T = RM2/2.
      ZNI= -RN/TSN
      ZMI1 = -RM1T/TSM
      ZMI2 = -RM2T/TSM
      RM1T = RM1T - WM
      RM2T = RM2T-WM
      RN=RN-WN
      XNOSE=PAON*VON/RN - VON/AAN
      XMAIN1=PAOM*VOM/RM1T-VOM/AAM
      IF(RM1T.GT.252000.)  XMAIN1 = 5223296./RM1T - 37.89
      IF(RM2T.GT.252000.) XMAIN2 = 5223296./RM2T - 37.89
      THETAI=((XMAIN1+ZMI1)-(XNOSE+ZNI))/(B+A)
      XMAIN2T = XMAIN1-THETAI*(A+C) -ZMI2 +ZMI1
      ZCGI = XMAIN1-A*THETAI+ ZMI1
      IF(RM1.GT.450000.) GO TO 20
      IF(ABS(XMAIN2-XMAIN2T).LT..006) GO TO 30
      GO TO 10
20    WRITE(6,40)
40    FORMAT(1X,*NO INITIAL CONDITIONS HAVE BEEN FOUND*)
30    IF(ZNI.GT.0.0) GO TO 10
      RETURN
      END
```

```
      SUBROUTINE COEFF (Y,  A,B,C,D)
      DIMENSION Y(4)
*********************************************************************
C  THIS IS THE COEFF SUBROUTINE FOR A C-5A AIRCRAFT SIMULATION
*********************************************************************
1     A=Y(2)
      B=Y(1)
      C=(25.*Y(1)+56.*Y(2)-64.*Y(3)+8.*Y(4))/(-128.)
      D=(-16.*Y(1)-12.*Y(2)+16.*Y(3)-4.*Y(4))/(-128.)
      RETURN
      END
```

```
      SUBROUTINE TLOOK (X,SLOPE,YCEPT,S,P,N)
      DIMENSION S(30),P(30)
**********************************************************************
C  THIS IS THE TLOOK SUBROUTINE FOR A C-5A AIRCRAFT SIMULATION
**********************************************************************
C
C     THIS IS A 2 DIMENSIONAL TABLE LOOK UP ROUTINE
C     WITH LINEAR INTERPOLATION
C
C   X  IS THE CURRENT VALUE OF STROKE
C   SLOPE AND YCEPT ARE CALCULATED AND RETURNED
C   S AND P  MAKE UP THE TABLE
C   N IS THE NUMBER OF VALUES IN THE TABLE
      DO 1 I=1,N
      IF(X.GE.S(I).AND.X.LT.S(I+1))GO TO 2
 1     CONTINUE
 2    SLOPE=(P(I+1)-P(I))/(S(I+1)-S(I)+.01)
      YCEPT=P(I)-SLOPE*S(I)
      RETURN
      END
```

```
      SUBROUTINE TAYLOR(T,TD,TCD)
*****************************************************************
C   THIS IS THE TAYLOR SUBROUTINE FOR A F-4 AIRCRAFT SIMULATION
*****************************************************************
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
      COMMON/FLEX2/NFM,GM(15),CMEGA(15)
      COMMON/FLEX3/Q(15),QD(15),QDD(15)
      COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,MMI
      COMMON/X2/PACM,VOM,AAM,AMM,OAM
      COMMON/X3/PACN,VON,AAN,AHN,OAN
      COMMON/X4/SXM,SXN,SLM,SLN,TSM ,TSN
      COMMON/X5/CL,CD,AREA,THRUST
      COMMON/X6/Z,REACTM,REACTN,DX,NTRUN,SPEED
      COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN
      COMMON/X8/STROKM(20),PINDM(20),STROKN(20),PINDN(20),NSCM,NSCN
      COMMON/X9/FSM,FSN,FTM,FTN,XMAIN,XNOSE,V  M,VELN
      COMMON/X10/ZPM,ZPN
      DIMENSION T(12), TD(12), TDD(12)
      REAL MCG,MM,MN,MMI
 1    Z=Z+TD(10)*DX+TDD(10)*DX**2/2.
      ZPM=AM+BM*Z+CM*Z**2+DM*Z**3
      ZPN=AN+BN*Z+CN*Z**2+DN*Z**3
       QTN=0.
      QTM=0.
      QTDN=0.
       QTDM=0.
       DO 10  I=1,NFM
       QTN=QTN+Q(I)*SINOSE(I)
      QTM=QTM+Q(I)*SIMAIN(I)
       QTDM=QTDM+QD(I)*SIMAIN(I)
10     QTDN=QTDN+QD(I)*SINOSE(I)
      XNOSE =  (T(2) - B * T(8) - T(6)) +QTN
      XMAIN =  (T(2) + A * T(8) - T(4)) +QTM
      VELM = TD(2) + A * TD(8) - TD(4) +QTDM
      VELN = TD(2) - B * TD(8) - TD(6) +QTDN
      IF(XMAIN.GE.0.) XMAIN=-.1
      IF(XNOSE.GE.0.) XNOSE=-.1
      IF(VELM.EQ.0.) VELM=-.1
      IF(VELN.EQ.0.) VELN=-.1
      XMLK=ABS(XMAIN)
      XNLK=ABS(XNOSE)
C  NOSE AND MAIN DAMPING COEFF
      CALL TLOCK(XMLK,SLOPEM,YCEPM,STROKM,PINDM,NSCM)
      CALL TLOCK(XNLK,SLOPEN,YCEPN,STROKN,PINDN,NSCN)
      AOM = SLOPEM*ABS(XMAIN) + YCEPM
      AON = SLOPEN*   (XNOSE) + YCEPN
      IF(ABS(XMAIN)   .13.88.AND.VELM.LT.0.0) AOM = AOM + .04906
      IF(VELN.GT.0.0) AON =.8552-AON
      IF(VELM.GT.0.0) AOM = .895 - AOM + .4536
      CON=(.00038*(AHN**3.))/(2.*(.9*AON)**2)
      COM=(.00038*(AHM**3.))/(2.*(.9*AOM)**2)
      IF(VELN.GT.0.0.AND.ABS(XMAIN).GT.13.86) COM = COM + 18.72
C  NOSE AND MAIN STRUT PNEUMATIC FORCES
      IF(ABS(XMAIN).GT.13.90) SSM = 19551.73/(2.2925-ABS(XMAIN+13.86))
      IF(ABS(XMAIN).LT.13.86) SSM = (PACM*VOM)/(((VOM/AAM)-ABS(XMAIN)))
      IF(ABS(XMAIN).GE.13.86.AND.ABS(XMAIN).LE.13.90) SSM = (1865.
     1+ 171000.*(ABS(XMAIN)-13.86))
      SSN=(PACN*VON)/(((VON/AAN)-XNLK))
```

```
      FTM = SXM * TSM * (T(4) - ZPM)
      FTN =SXN* TSM * (T(6) - ZPN)
      IF(FTM.GT.0.)FTM=0.
      IF(FTN.GT.0.)FTN=0.
      FSN=SXN*(-SSN+CON*VELN*ABS(VELN) )
      FSM=SXM*(-SSM +COM*VELM*ABS(VELM) )
      IF(ABS(XMAIN).GE.15.88) FSM = FSM +10000000.*(XMAIN + 15.88)
      IF(FSM.GT.0.0) FSM = 0.0
      IF(FSN.GT.0.0) FSN = 0.0
      VLIFT =.001189*CL*AREA*(TD(10)*TD(10))
      DRAGA=VLIFT*CD/CL
      DRAGT =ABS(.025*FTM+.025  *FTN          )
      IF(NTRUN.EQ.1) GO TO 20
      IF(TD(10) .LT. SPEED) GO TO 20
      THRUST=DRAGA+DRAGT
20    TDD(2) = (-FSN-FSM-MCG*386.+VLIFT)/MCG
      TDD(4)=(FSM-FTM-386.*SXM*MM)/(MM*SXM)
      TDD(6)=(FSN-FTN-MN*386.*SXN)/(MN*SXN)
      TDD(8) =-(FSM*A -FSN*B -DRAGT *(SLM+XMAIN))/MMI
      TDD(10) = (THRUST-DRAGA-DRAGT)/((MCG*12.))
      DO 30  I=1,NFM
30     QDD(I)=-(SIMAIN(I)*(FSM-REACTM)+SINOSE(I)*(FSN-REACTN)
     1+.10*OMEGA(I)*QD(I)*GM(I)+OMEGA(I)**2*GM(I)*Q(I))/GM(I)
      DX=.001
      IF(ABS(XMAIN).GE.13.85.AND.ABS(XMAIN).LE.13.91) DX = .0001
      DO 40   I = 2,10,2
      T(I) = T(I) + TD(I)*DX + (TDD(I)*DX**2)/2.
40    TD(I) = TD(I) + TDD(I)*DX
      DO 50   I=1,NFM
      Q(I)=Q(I)+QD(I)*DX+(QDD(I)*DX**2)/2.
50    QD(I)=QD(I)+QDD(I)*DX
      RETURN
      END
```

```
      SUBROUTINE IC(  ZCGI,ZMI,ZNI,THETAI)
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
      COMMON/FLEX2/NFM,GM(15),OMEGA(15)
      COMMON/FLEX3/Q(15),QD(15),QDD(15)
      COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,PMI
      COMMON/X2/PACM,VOM,AAM,AHM,OAM
      COMMON/X3/PAON,VON,AAN,AHN,OAN
      COMMON/X4/SXM,SXN,SLM,SLN,TSM ,TSN
      COMMON/X5/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VELM,VELN
**************************************************************************
C  THIS IS THE IC SUBROUTINE FOR A F-4 AIRCRAFT SIMULATION
**************************************************************************
******************************************************************************
C THIS PROGRAM WILL FIND THE INITIAL CONDITIONS FOR  TAXI
C  FOR SXM MAIN AND SXN NOSE GEAR
C  ZMI= MAIN GEAR TIRE DEFLECTION 35 PERCENT
C  ZNI= NOSE GEAR TIRE DEFLECTION 35 PERCENT DEFLECTION
C  ZCGI= CG DEFLECTION
C  THETAI= PITCH ANGLE
C  XMAIN=  MAIN LANDING GEAR STATIC STROKE
C  XNOSE=  NOSE GEAR STATIC STROKE
******************************************************************************
1     RM=W/(1.+A/B)
      RN=W-RM
      RM=RM/SXM
      RN=RN/SXN
      ZMI=-RM/TSM
      ZNI=-RN/TSN
      RSM=RM-WM
      RSN=RN-WN
      XNOSE=+PAON*VON/RSN-VON/AAN
      XMAIN=+PACM*VOM/RSM-VOM/AAM
      IF(ABS(XMAIN).LT.13.88) GO TO 10
      XMAIN = 0.
20    XMAIN = XMAIN - .001
      RSMT = (PACM*VOM)/(((VOM/AAM)-ABS(XMAIN)))
      IF(ABS(XMAIN).GE.13.88) RSMT =       + (19546.)/
     1(((2.298)      -ABS(XMAIN + 13.88)))
      IF(ABS(RSM - RSMT).LT.50.0) GO TO 10
      GO TO 20
10    THETAI=-(XNOSE+ZNI-(XMAIN+ZMI))/(B+A)
      ZCGI=XMAIN-A*THETAI+ZMI
       DO 30 I=1,NFM
       QD(I)=0.
30    Q(I)=0.
      RETURN
      END
```

```
      SUBROUTINE TAYLOR(T,TD,TDD)
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
      COMMON/FLEX2/NFM,GM(15),OMEGA(15)
      COMMON/FLEX3/Q(15),QD(15),QDD(15)
      COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,MMI
      COMMON/X2/PACM,VOM,AAM,AMM,OAM
      COMMON/X3/PACN,VON,AAN,AMN,OAN
      COMMON/X4/SXM,SXN,SLM,SLN,TSM ,TSN
      COMMON/X5/CL,CD,AREA,THRUST
      COMMON/X6/Z,REACTM,REACTN,DX,NTRUN
      COMMON/X7/AM,BM,CM,DM,AN,BN,CN,DN
      COMMON/X8/STROKM(20),PINOM(20),STROKN(20),PINON(20),NSCM,NSCN
      COMMON/X9/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VELM,VELN
      COMMON/X10/ZPM,ZPN
      COMMON/X11/SSM,QTDM,QTM
      DIMENSION T(12), TD(12), TDD(12)
      REAL MCG,MM,MN,MMI
C  F-111  TAYLOR SUBROUTINE
 1    Z=Z+TD(10)*DX+TDD(10)*DX**2/2.
 120  ZPM=AM+BM*Z+CM*Z**2+DM*Z**3
      ZPN=AN+BN*Z+CN*Z**2+DN*Z**3
       QTN=0.
      QTM=0.
      QTDN=0.
       QTDM=0.
       DO 130 I=1,NFM
       QTN=QTN+Q(I)*SINOSE(I)
      QTM=QTM+Q(I)*SIMAIN(I)
       QTDM=QTDM+QD(I)*SIMAIN(I)
 130   QTDN=QTDN+QD(I)*SINOSE(I)
      XNOSE =  (T(2) - B * T(8) - T(6)) +QTN
      XMAIN =((T(2) + A * T(8) - T(4)) +QTM )*.66
      VELM =(TD(2) + A * TD(8) - TD(4) +QTDM)*.66
      VELN = TD(2) - B * TD(8) - TD(6) +QTDN
      IF(XMAIN.GE.0.) XMAIN=-.1
      IF(XNOSE.GE.0.) XNOSE=-.1
      IF(VELM.EQ.0.) VELM=-.1
      IF(VELN.EQ.0.) VELN=-.1
      XMLK=ABS(XMAIN)
      XNLK=ABS(XNOSE)
C  NOSE AND MAIN DAMPING COEFF
      CALL TLOCK(XMLK,SLOPEM,YCEPM,STROKM,PINOM,NSCM)
      CALL TLOCK(XNLK,SLOPEN,YCEPN,STROKN,PINON,NSCN)
      AOM = (SLOPEM*XMLK+YCEPM)
      AON =(SLOPEN*XNLK+ YCEPN)
      CON=(.00028*(AMN**3.))/(2.*(.9*AON)**2)
      COM=(.00028*(AMM**3.))/(2.*(.9*AOM)**2)
C  NOSE AND MAIN STRUT PNEUMATIC FORCES
      SSM=(PACM*VOM)/(((VOM/AAM)-(XMLK-14.475)))
      SSN=(PACN*VON)/(((VON/AAN)-XNLK))
      IF(XMLK.GT.0..AND.XMLK.LT.14.275)SSM=4790.+201.7*XMLK
      IF(XMLK.GE.14.275.AND.XMLK.LE.14.475)SSM=7669.+189440.
     1*(XMLK-14.275)
      FTM = SXM * TSM * (T(4) - ZPM)
      FTN =SXN* TSN * (T(6) - ZPN)
```

```
      IF(FTM.GT.0.)FTM=0.
      IF(FTN.GT.0.)FTN=0.
      FSN=SXN*(-SSN+CON*VELN*ABS(VELN) )
      FSM=SXM*(-SSM +COM*VELM*ABS(VELM) )*.66
      VLIFT =.001189*CL*AREA*(TD(10)*TD(10))
      DRAGA=VLIFT*CD/CL
      DRAGT =ABS(.025*FTM+.025*FTN)
      IF(NTRUN.EQ.1) GO TO 125
      THRUST=DRAGA+DRAGT
125   TDD(2) = (-FSN-FSM-MCG*386.+VLIFT)/MCG
      TDD(4)=(FSM-FTM-386.*SXM*MM)/(MM*SXM)
      TDD(6)=(FSN-FTN-MN*386.*SXN)/(MN*SXN)
      TDD(8) =-(FSM*A -FSN*B -DRAGT *(SLM+XMAIN))/MMI
      TDD(10) = (THRUST-DRAGA-DRAGT)/((MCG*12.))
      DO 200 I=1,NFM
200    QDD(I)=-(SIMAIN(I)*(FSM-REACTM)+SINOSE(I)*(FSN-REACTN)
     1+.10*OMEGA(I)*QD(I)*GM(I)+OMEGA(I)**2*GM(I)*Q(I))/GM(I)
      DX=.001
      IF(XMLK.GE.14.275.AND.XMLK.LT.14.475) DX=.0001
      DO 1001 I = 2,10,2
      T(I) = T(I) + TD(I)*DX + (TDD(I)*DX**2)/2.
1001  TD(I) = TD(I) + TDD(I)*DX
      DO 1002 I=1,NFM
      Q(I)=Q(I)+QD(I)*DX+(QDD(I)*DX**2)/2.
1002  QD(I)=QD(I)+QDD(I)*DX
      RETURN
      END
```

```
      SUBROUTINE IC(  ZCGI,ZMI,ZNI,THETAI)
      COMMON/FLEX1/SIMAIN(15),SINOSE(15),SICG(15),SITAIL(15),SIPS(15)
      COMMON/FLEX2/NFM,GM(15),OMEGA(15)
      COMMON/FLEX3/Q(15),QD(15),QDD(15)
      COMMON/X1/W,WM,WN,MCG,MM,MN,A,B,MMI
      COMMON/X2/PACM,VOM,AAM,AHM,OAM
      COMMON/X3/PACN,VON,AAN,AHN,OAN
      COMMON/X4/SXM,SXN,SLM,SLN,TSM ,TSN
      COMMON/X5/FSM,FSN,FTM,FTN,XMAIN,XNOSE,VELM,VELN
***********************************************************************
C   F-111  IC SUBROUTINE
C THIS PROGRAM WILL FIND THE INITIAL CONDITIONS FOR  TAXI
C  FOR SXM MAIN AND SXN NOSE GEAR
C  ZMI= MAIN GEAR TIRE DEFLECTION 35 PERCENT
C  ZNI= NOSE GEAR TIRE DEFLECTION 35 PERCENT DEFLECTION
C  ZCGI= CG DEFLECTION
C  THETAI= PITCH ANGLE
C  XMAIN=  MAIN LANDING GEAR STATIC STROKE
C  XNOSE=  NOSE GEAR STATIC STROKE
**********************************************************************
      RM=W/(1.+A/B)
      RN=W-RM
      RM=RM/SXM
      RN=RN/SXN
      ZMI=-RM/TSM
      ZNI=-RN/TSN
      RSM = (RM -WM)/.66
      RSN=RN-WN
      XNOSE=+PAON*VON/RSN-VON/AAN
      XMAIN=(+PAOM*VOM/RSM-VOM/AAM-14.375 )
      IF(RSM.GE.7669..AND.RSM.LT.45557.) XMAIN = -(RSM+2696587.)/189440.
      XMA66=XMAIN/.66
      THETAI=-(XNOSE+ZNI-(XMA66+ZMI))/(B+A)
      ZCGI=XMA66-A*THETAI+ZMI
       DO 10 I=1,NFM
       QD(I)=0.
 10   Q(I)=0.
      RETURN
      END
```

APPENDIX II

FORTRAN SYMBOL DEFINITIONS

This appendix contains an alphabetical listing of the Fortran variables used in the program TAXI categorized by the subroutine in which they are defined. In cases where a variable is defined in two or more subroutines, it is listed under the subroutine in which it is used most often. Some symbols used in the C-5A computer code are not listed. These variables are those which have been formed by adding a 1 or 2 to a variable name which is contained in the basic TAXI computer code. The 1 refers to the rear set of main gear and the 2 refers to the front set of main gear of the C-5A aircraft. Thus, a variable such as FSM1 in the C-5A code may be found by looking for the variable FSM in the listing of symbols and associating the definition of the variable with the rear set of main gear of the aircraft. Some variables denoted (C-5A simulation only) are those contained in the C-5A computer code exclusively.

APPENDIX II

FORTRAN SYMBOL DEFINITIONS

TAXI

SYMBOL	DEFINITION
A	Distance from CG to rear main gear
AAM	Pneumatic area, main gear
AAN	Pneumatic area, nose gear
AHM	Hydraulic area, main gear
AHN	Hydraulic area, nose gear
AM	Coefficient of polynomial fit to runway profile segment, rear main gear
AMA	Coefficient of polynomial fit to runway profile segment, front main gear(C-5A simulation only
AN	Coefficient of polynomial fit to runw ./ .rofile segment, nose gear
AREA	Aircraft wing area
B	Distance from CG to nose gear
BM	Coefficient of polynomial . to runway profile segment, rear main gear
BMA	Coefficient of polynomial fit to runway profile segment, front main gear (C-5A simulation only)
BN	Coefficient of polynomial fit to runway profile segment, nose gear
C	Distance from CG to front main gear (C-5A simulation only)
CD	Coefficient of drag
CGACC	Array containing CG accelerations for Calcomp plot
CGOUT	Total CG acceleration
CL	Coefficient of lift

SYMBOL	DEFINITION
CM	Coefficient of polynomial fit to runway profile segment, rear main gear
CMA	Coefficient of polynomial fit to runway profile segment, front main gear (C-5A simulation only)
CN	Coefficient of polynomial fit to runway profile segment, nose gear
DDPLOT	Array containing aircraft distance down the runway for Calcomp plot
DISTAN	Distance down the runway used in removing overall slope from runway profile
DM	Coefficient of polynomial fit to runway profile segment, rear main gear
DMA	Coefficient of polynomial fit to runway profile segment, front main gear (C-5A simulation only)
DN	Coefficient of polynomial fit to runway profile segment, nose gear
DX	Time step for integration
DZ	Variable which compensates for the overlap of two adjacent runway segments
ELEV	Array containing runway profile elevations
ELEV1	Elevation of first runway profile point
ENDRUN	Length of runway
GM	Array containing generalized masses for each flexible mode of vibration
HDR	Counter for printing header on printed output
I	Index variable
IFPLOT	Variable which contains decision to produce plotted output or not
II	Subscript variable for runway markers on Calcomp plot

SYMBOL	DEFINITION
ITT	Index variable
IVAL	Integer truncation of distance between nose and rear main gear
IV[illegible]A	Integer truncation of distance between rear main gear and front main gear (C-5A simulation only)
IXLONG	Integer truncation of length of time axis on Calcomp plot
J	Subscript variable for runway profile
LD	Counting variable for runway profile input
LD1	Counting variable for runway profile output listing
LL	Subscript variable for storage of pilot station acceleration time history
LLL	Subscript variable for storage of aircraft speed and distance for Calcomp plot
LPRIN	Runway distance for runway profile listing
LSD	Counting variable for runway profile input
LSD1	Counting variable for runway profile listing
M	Counting variable for printing out output header first time
MCG	Mass of entire aircraft
MGM	Integer truncation of total simulation time
MM	Mass of unsprung portion of one main landing gear
MMI	Pitching moment of inertia about aircraft center of gravity
MN	Mass of the unsprung portion of the nose landing gear
MRM	Length of runway divided by 1000 feet
NFM	Number of flexible modes
NN	Subscript variable for CG acceleration time history

SYMBOL	DEFINITION
NPTSS	Number of runway profile points
NSCM	Number of slope or area changes on main strut metering pin
NSCN	Number of slope or area changes on nose strut metering pin
NTRUN	Defines run as taxi or takeoff
N10	Index variable for normalization of runway profile
OAM	Area of orifice hole, main gear
OAN	Area of orifice hole, nose gear
OMEGA	Array of flexible mode frequencies
PAOM	Preload pressure of main gear strut
PAON	Preload pressure of nose gear strut
PINDM	Array containing main gear metering pin diameters for conventional aircraft and net orifice areas for aircraft with metering tubes or flutted metering pins
PINDN	Array containing nose gear metering pin diameters for conventional aircraft and net orifice areas for aircraft with metering tubes or flutted metering pins
PLANE	Aircraft being simulated
PP	Counting variable for storage of distance and speed for Calcomp plot
PROF	Runway profile time history elevations
PROF10	PROF (NN+2)X10
PSA	Pilot station acceleration
PSACC	Array containing pilot station acceleration time history
PSARM	Distance from pilot station to CG
Q	Array of non-dimensional time dependent coordinates which weight the amount of motion due to each flexible mode in the total motion of the aircraft

SYMBOL	DEFINITION
QD	Time derivative of Q
QDD	Time derivative of QD
QDDCG	CG acceleration due to flexible motion
QDDPS	Pilot station acceleration due to flexible motion
QDDTAL	Tail station acceleration due to flexible motion
REACTM	Static, total force at main gear
REACTN	Static, total force at nose gear
RM	Incremented variable for determining position of runway markers
RMARK	Array containing runway markers positions
SICG	Mode shape deflection of CG
SIMAIN	Mode shape deflection at main landing gear
SINOSE	Mode shape deflection at nose landing gear
SIPS	Mode shape deflection at pilot station
SITAIL	Mode shape deflection at tail station
SITE	Location of runway
SLM	Distance from CL of main gear axle to CG of aircraft with strut fully extended
SLN	Distance from CL of nose gear axle to CG of aircraft with strut fully extended
SLP	Overall slope of runway profile
SPEED	Initial speed of aircraft
SSPLOT	Array of velocity of aircraft for Calcomp plot
STORE1	Temporary storage space for CG accelerations

SYMBOL	DEFINITIONS
STORE2	Temporary storage space for CG accelerations
STORE3	Temporary storage space for pilot station accelerations
STORE4	Temporary storage space for pilot station accelerations
STROKM	Array of strut stroke values corresponding to metering pin values (PINDM), main gear
STROKN	Array of strut stroke values corresponding to metering pin values (PINDN), nose gear
SXN	Number of main gear struts
SXN	Number of nose gear struts
TAILAC	Acceleration at tail station
TAILRM	Distance from tail station to CG
TAKOFF	Rotation velocity of aircraft
THRUST	Total thrust of aircraft
TIME	Array of simulation times at which CG acceleration time history points are stored
TIMEX	Counter variable for printed output
TIME1	Array of simulation times at which pilot station time history are stored
TSM	Tire spring constant, main gear
TSN	Tire spring constant, nose gear
TYPRUN	Defines simulation as takeoff or taxi
VAL	Distance between nose and rear main gear
VALA	Distance between rear main gear and front main gear (C-5A simulation only)
VOM	Main gear strut fully extended volume

SYMBOL	DEFINITION
VON	Nose gear strut fully extended volume
W	Weight of aircraft
WM	Main gear unsprung weight
WN	Nose gear unsprung weight
X	Simulation time
XLONG	Length of time axis for Calcomp plot
XLONG2	XLONG/2
XPROF	Location for printing of "NOSE GEAR TRACK" on Calcomp plot
XSTOP	XLONG+5
YP	Array containing runway segment elevation points and slope from end of previous segment, rear main gear
YPA	Array containing runway segment elevation points and slope from end of previous segment, front main gear (C-5A simulation only)
YPN	Array containing runway segment elevation points and slope from end of previous segment, nose gear
ZADOT	Slope of runway segment at end point, front main gear (C-5A simulation only)
ZNDOT	Slope of runway segment at end point, nose gear

TAYLOR

AOM	Net orifice area, main gear (OAM-metering pin area)
AON	Net orifice area, nose gear (OAN-metering pin area)
COM	Damping coefficient, main gear
CON	Damping coefficient, nose gear
DRAGA	Aerodynamic drag

SYMBOL	DEFINITION
DRAGT	Rolling Drag
FSM	Total force in all main gear struts
FSN	Total force in all nose gear struts
FSTN	Net force on secondary piston, nose gear (C-5A Simulation only)
FST1	Net force on secondary piston, rear main gear (C-5A Simulation only)
FST2	Net force on secondary piston, front main gear (C-5A Simulation only)
FTM	Force in tires, main gear
FTN	Force in tires, nose gear
F2M1	Total force in secondary chamber, rear main gear (C-5A simulation only)
F2M2	Total force in secondary chamber, front main gear (C-5A simulation only)
F2N	Total force in secondary chamber, nose gear (C-5A simulation only)
QTDM	Total velocity due to flexible modes at main gear
QTDN	Total velocity due to flexible modes at nose gear
QTM	Total deflection due to flexible modes at main gear
QTN	Total deflection due to flexible modes at nose gear
SLOPEM	Slope of line drawn through two metering pin points, main gear
SLOPEN	Slope line drawn through two metering pin points, nose gear
SSM	Pneumatic force, main gear
SSN	Pneumatic force, nose gear
T(2)	CG vertical displacement
T(4)	Unsprung mass vertical displacement, front main gear
T(6)	Unsprung mass vertical displacement, nose gear

SYMBOL	DEFINITION
T(8)	Rigid body pitch angle of aircraft
T(10)	Horizontal distance of aircraft
T(12)	Unsprung mass vertical displacement, front main gear (C-5A simulation only)
T(14)	Vertical displacement of secondary piston, nose gear (C-5A simulation only)
T(16)	Vertical displacement of secondary piston, front main gear (C-5A simulation only)
T(18)	Vertical displacement of secondary piston, rear main gear (C-5A simulation only)
TD(2)	Time derivative of T(2)
TD(4)	Time derivative of T(4)
TD(6)	Time derivative of T(6)
TD(8)	Time derivative of T(8)
TD(10)	Time derivative of T(10)
TD(12)	Time derivative of T(12) (C-5A simulation only)
TD(14)	Time derivative of T(14) (C-5A simulation only)
TD(16)	Time derivative of T(16) (C-5A simulation only)
TD(18)	Time derivative of T(18) (C-5A simulation only)
TDD(2)	Time derivative of TD(2)
TDD(4)	Time derivative of TD(4)
TDD(6)	Time derivative of TD(6)
TDD(8)	Time derivative of TD(8)
TDD(10)	Time derivative of TD(10)
TDD(12)	Time derivative of TD(12) (C-5A simulation only)
TDD(14)	Time derivative of TD(14) (C-5A simulation only)
TDD(16)	Time derivative of TD(16) (C-5A simulation only)

SYMBOL	DEFINITION
TDD(18)	Time derivative of TD(18) (C-5A simulation only)
VELM	Total strut velocity, main gear
VELN	Total strut velocity, nose gear
VLIFT	Aerodynamic lift force
XMAIN	Strut stroke, main gear
XMLK	Absolute value of XMAIN
XNLK	Absolute value of XNOSE
XNOSE	Strut stroke, main gear
YCEPM	Y intercept of line drawn through metering pin points, main gear
YCEPN	Y intercept of line drawn through two metering pin points, nose gear
Z	Distance of aircraft from beginning of a 4 ft runway segment
ZPM	Runway elevation, rear main gear
ZPMA	Runway elevation, front main gear (C-5A simulation only)
ZPN	Runway elevation, nose gear (C-5A simulation only)

IC

RM	Static reaction force at main gear
RM1T	Static reaction force at rear main gear (C-5A simulation only)
RM2T	Static reaction force at front main gear (C-5A simulation only)
RN	Static reaction force at nose gear
RSM	RM - WM
RSN	RN - WN
THETAI	Rigid body initial pitch angle
XMAIN2T	Test variable for rigid body initial conditions (C-5A simulation only)

SYMBOL	DEFINITION
ZCGI	Initial CG vertical displacement
ZMI	Initial tire deflection, main gear
ZNI	Initial tire deflection, nose gear
COEFF	
A	Coefficient of polynomial fit to runway profile segment
B	Coefficient of polynomial fit to runway profile segment
C	Coefficient of polynomial fit to runway profile segment
D	Coefficient of polynomial fit to runway profile segment
Y	Runway profile elevation values
TLOOK	
I	Index variable
N	Number of values in metering pin - stroke table
P	Metering pin diameter or net orifice area for aircraft with metering tubes or fluted metering pins
S	Strut stroke in metering pin table
SLOPE	Slope of line drawn between two metering pin points
YCEPT	Y intercept of line drawn between two metering pin points